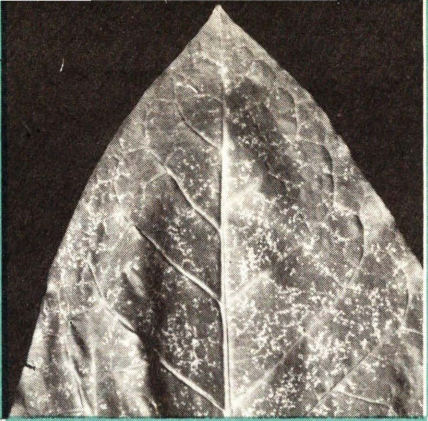
Spring 1971

South Dakota Farm & Home Research

Agricultural Experiment Station, South Dakota State University

South Dakota Farm & Home RESEARCH



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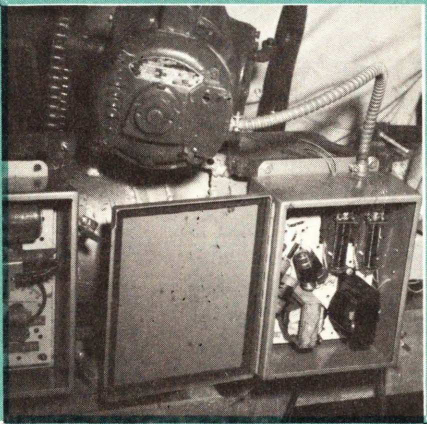

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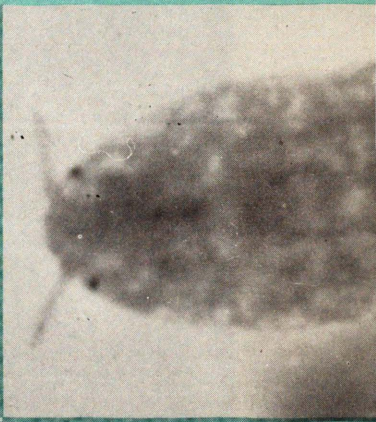

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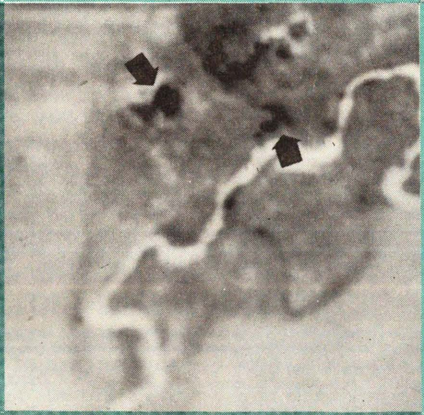

range
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IBP
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No. 2
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Spring 1971

Agricultural
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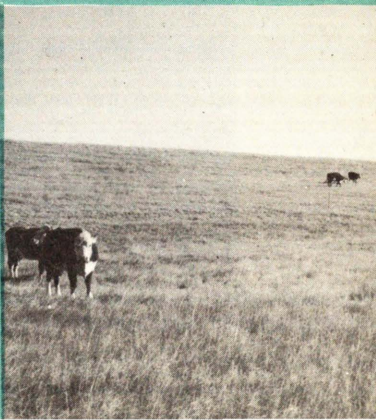
South Dakota
State University
Brookings, S. D.



From the Dean and Director . . .

Field Days Scheduled

Duane Acker

AGRICULTURAL research results which are in evidence everywhere, again this year will be featured at four visitors' days.

These field days offer South Dakotans an opportunity to see results of research that have a direct bearing on an individual's income and, of course, this is reflected in the economy for the entire state. It is a team effort as far as South Dakota State University is concerned with research by the Agricultural Experiment Station and information dissemination by the Cooperative Extension Service.

The first field day in the summer series is at the South Central Crops and Soils Research Farm near Presho on Wednesday, June 30 from 6:30 to 8:30 p.m. The Farm is 1 mile east and 11 miles south of Presho on highway U. S. 183. To be included in the program: winter wheat breeding, small grain varieties, chemicals for mosaic control, new sorghums.

A new Plant Science building will be dedicated at the outset of the field day to be held at Brookings headquarters of the Agricultural Experiment Station on Thursday, July 8, from 10 a.m. to 4 p.m. The tour of crops and soils field research at the Agronomy and Plant Pathology Farms east of the SDSU campus begins at 12:30 p.m. and is the first to be held since 1967. The tour will include: small grain breeding, forage crop breeding, plant diseases, weed control research, row spacing of soybeans, soil fertility.

On Tuesday, July 13 the Pasture Research Center in Faulk County will have its second field day. The Center is 1 mile north of Norbeck on Highway 20, or 16 miles northwest of Faulkton, or 50 miles southwest of Aberdeen. The 10:30 to 4 p.m. program will include: interseeding, cattle performance, seasonal pastures, pasture fertilization, switchgrass for pastures, and chemical establishment of alfalfa.

Final summer series field day is at the Corn Belt Agricultural Research and Extension Center at the Southeast South Dakota Experiment Farm on Friday, September 17. The Farm is 6 miles west and 3 miles south of the Beresford-Interstate 29 interchange. Featured during the program which begins at 10 a.m.: insect control in corn, weed control in corn and sorghum, soybean row spacing and population, corn row spacing, fertilizer on corn, swine management and feeding, beef cattle research.

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To simplify terminology, trade names of products or equipment are sometimes used. No endorsement of specific products or equipment named is intended, nor is criticism implied of those not mentioned.

A Report of Progress

Vol. XXII • Spring 1971 • No. 2

Duane Acker,
Dean, College of Agriculture and Biological Sciences, and Director, Agricultural Experiment Station.

A. L. Musson,
Associate Director, Agricultural Experiment Station.

Edited by: Frank J. Shideler, Editorial Office, South Dakota State University, Brookings, S. D. 57006

South Dakota
Farm & Home
RESEARCH

SERVING THE PEOPLE OF SOUTH DAKOTA THROUGH TEACHING, RESEARCH, EXTENSION

Rapid Changes in Soybeans Are a Result of Research

SOYBEANS have changed so rapidly the past few years because of agricultural research that growers are advised to check the advantages of new improved varieties to help keep South Dakota's $14 million annual soybean crop competitive.

That's the suggestion of A. O. Lunden, who is in charge of soybean research and evaluation for the Agricultural Experiment Station. Dr. Lunden also notes another reason for keeping tab on new developments: state soybean yield averages have been maintained in several recent unfavorable seasons only because of improved varieties.

The SDSU agronomist estimates that less than 25 per cent of the 1971 South Dakota acreage will be planted to varieties similar to those grown in 1966. Corsoy, which was released in the summer of 1967, will constitute about 40 per cent of the state's 1971 crop.

Details to County Agents

Detailed variety descriptions and yield data obtained from soybean research of the past several years have been summarized by Dr. Lunden and provided to county Extension agents as a source of information for growers.

Main changes listed by the research agronomist: Wayne has replaced most Ford acreage and some of Hawkeye; Corsoy has replaced Harosoy, Lindarin, and Hawkeye; and Anoka and Wirth will probably soon replace Chippewa. Dunn will probably be of limited use in the state while Clay, Norman, Grant and Traverse are too early. Adelphia and Calland are too late and Beeson has a poor yield record. Use of new high protein varieties will probably not be significant without extensive direct feeding of commercially processed cooked whole-beans or development of market premium for high protein content soybeans.

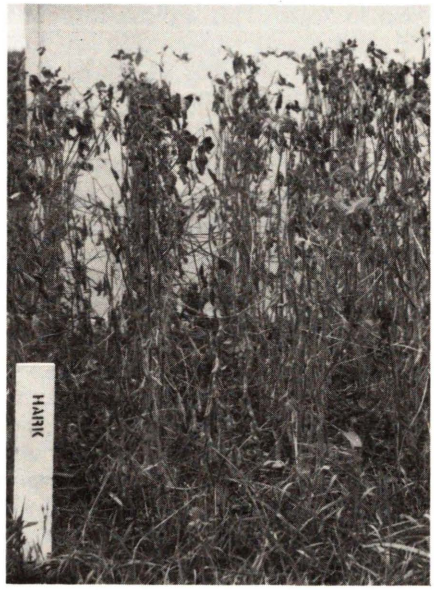
Current breeding and production research emphasizes development of improved varieties, production techniques using narrow rows, yield as influenced by plant and row spacing, and erosion potential of drill planted versus row crop soybeans.

Narrow Row Advantages

"The yield advantage of narrow row soybeans is known to be greater in northern areas and the erosion potential of wide row soybeans can be quite serious," Dr. Lunden adds. "Adequate winter protection is usually available following harvest of drill planted soybeans while row crop soybeans often provide cover only equivalent to modified summer fallow or fall plowing. Other advantages of drill planted soybeans are ease of harvest from increased height of pods above ground level, absence of row hilling from cultivation, lower per-acre production costs, and frequently increased yields."

Drill planted soybeans require effective weed control, uniform and not excessive plant population, and selection of a suitable variety. Chippewa and Dunn are not adapted to drill planting while Hark and Corsoy respond quite favorably to narrow rows, Dr. Lunden explains. Future research will stress expansion of the genetic pool for variety development, breeding for protein quantity and quality, continued use and improvement of herbicides and development of hybrids.

Soybean research and evaluation is conducted at Brookings, Redfield, Revillo, Twin Brooks, Beresford, and Elk Point.□



contents . . .

Cottonwood 'Outdoor Lab' Site for Grassland Biome Studies

An outdoor laboratory which has served western South Dakota for nearly 30 years last summer was given a slightly new look that is already providing dividends and research payoffs.

The new look itself didn't amount to a whole lot: converting an old chicken house into a compact little laboratory, re-aligning a few experimental plots, and installation of some new equipment. The cost to South Dakota was minimal.

The biggest change was involvement of South Dakota State University students and staff members in a comprehensive investigation of a piece of South Dakota. The change injected new people (SDSU students and staff members from several departments, many of both working voluntarily on an "own-time" basis) and some relatively "new" words ("ecosystem," "environment," "biome," "energy flow").

South Dakota's Part in IBP

This effort is centered in South Dakota's part in the International Biological Program which got underway last summer (see other articles in this issue). Field investigations are conducted at two sites on the 2,640-acre Range Field Station east of Cottonwood. One is a 5-acre permanent exclosure in excellent range condition and the other is a 2-acre temporary area excluded each year from a heavily grazed pasture in fair range condition.

Heading the SDSU contributing project to the Grassland Biome subprogram of IBP is J. K. "Tex" Lewis, associate professor in the Animal Science Department. Lewis has been conducting research for the past 21 years at Cottonwood, one of the few places in the northern Great Plains where comparisons can be made of changes in native range over the past third of a century due to different grazing intensities by cattle. Cottonwood's experimental pastures were established in 1942 and since have been used as an outdoor laboratory by researchers as well as by ranchers who have a "do-it-yourself" lab to make comparisons with their individual ranges and what might be done about them.

Aligned with Station Research

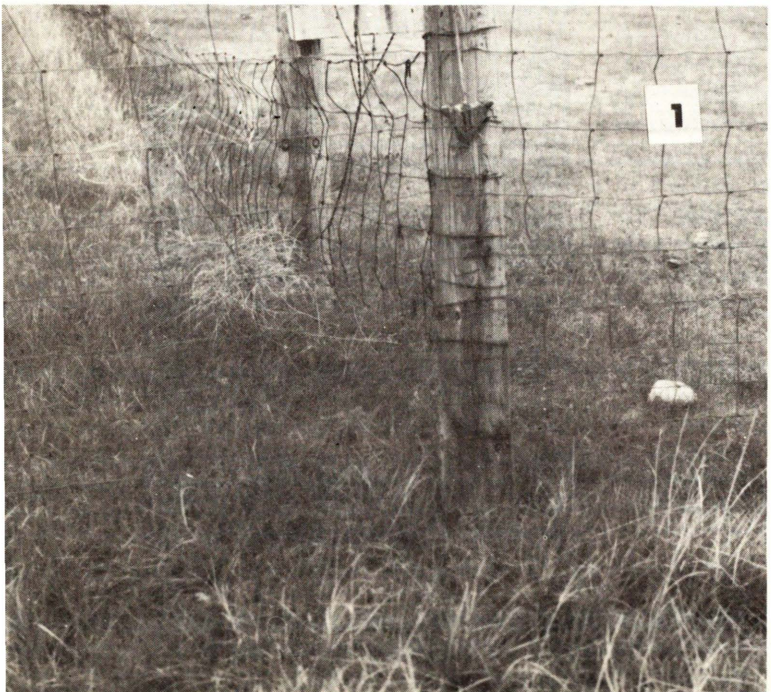
"Our main function is to collect South Dakota data for computer modeling at Colorado State University, Grassland Biome headquarters for more than a dozen universities gathering information on the grassland ecosystem," Lewis says. "While one aim of the Grassland Biome study is to be able to predict results of human manipulation of various types on the characteristics and productivity of grassland ecosystems, we've got some of our investigations aligned to be of use in regular Agricultural Experiment Station research—and even at this early date we are beginning to obtain important data."

Eventual aim of the Analysis of Ecosystems Program of which the Grassland Biome study is a part is a computerized method of viewing each major kind of ecosystem in the world from the standpoint of how it operates and what happens when man introduces certain of his activities, says Lewis. "In South Dakota, we may expect to come up with our own smaller scale computerized model which will show us just how certain practices will affect our grassland environment—good or bad."

Other Research Payoffs

At Cottonwood this research is paying off in other ways too:

Of immediate and direct inter-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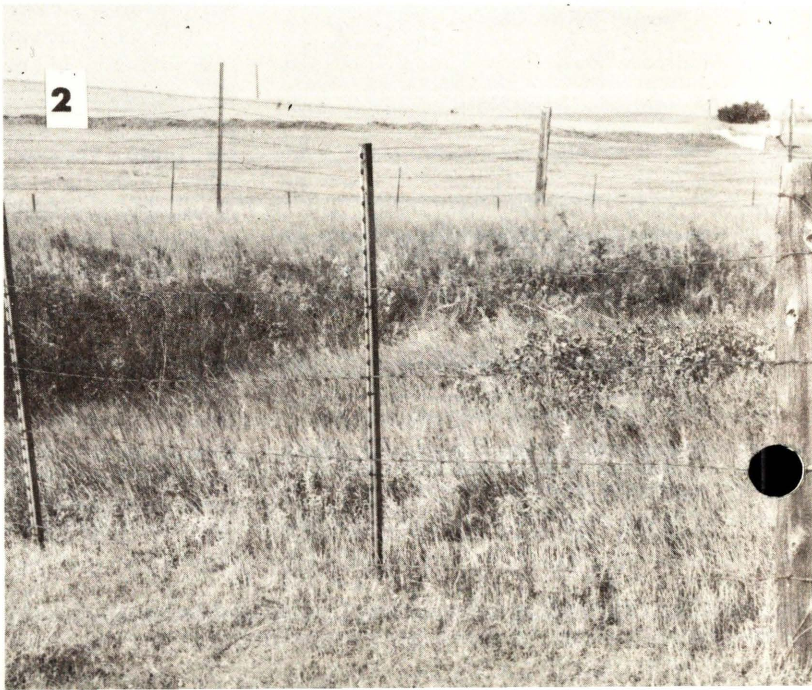
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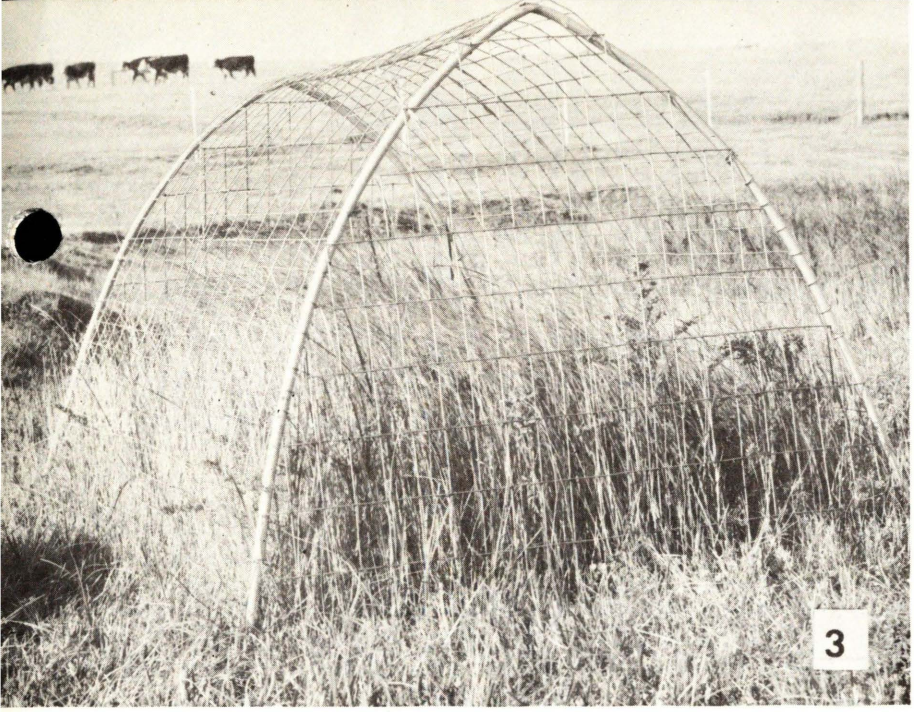


est to South Dakota were investigations last summer which provided information showing that scale insects consumed huge quantities of plant sap from range grass. Different insects by the dozens, some of them possibly never-before described or identified, are being found as range inhabitants in this concentrated grassland biome investigation at Cottonwood.

The SDSU investigations have *(continued on page 6)*

Photo Series

1—Different grazing rates in the past have resulted in different range condition classes as shown at this fence line intersection adjoining the Grassland Biome site at Cottonwood: excellent (foreground); good (upper left); and fair (upper right).

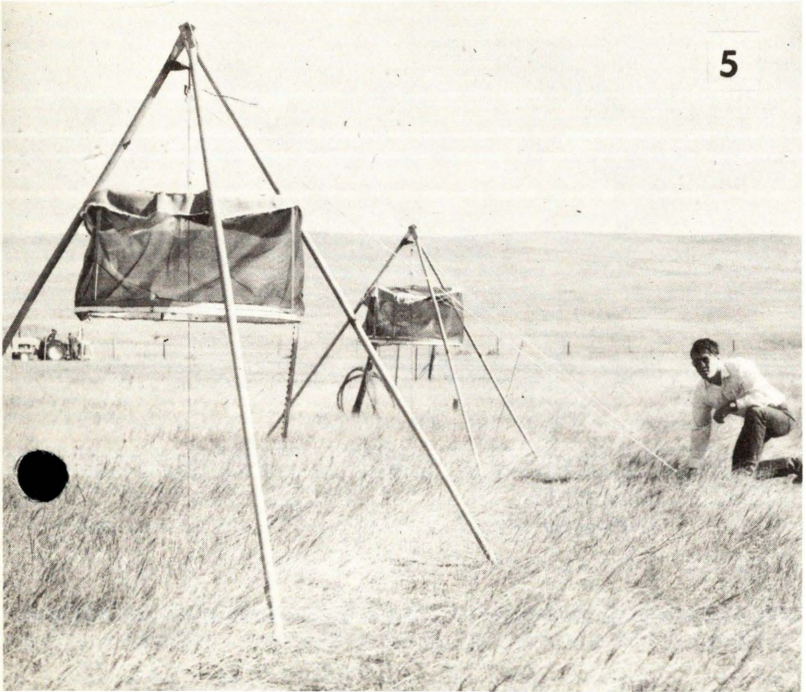
2—Range experiments have been conducted at the Range Field Station in western South Dakota since 1942. Fenced-off areas (sometimes termed "excluded") such as this provide an outdoor laboratory for both research and demonstration.

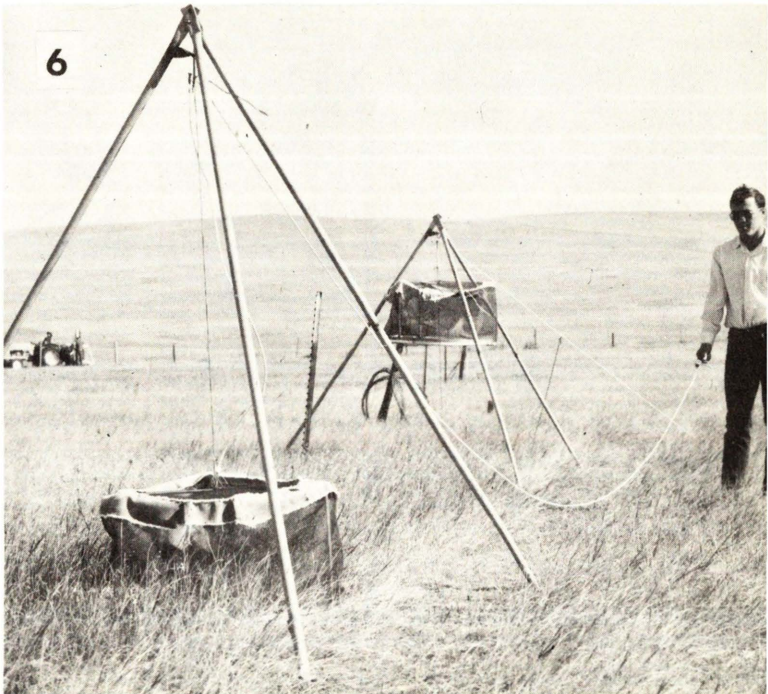
3—Range cages permit plants to grow undisturbed by cattle in small sections of experimental pastures.

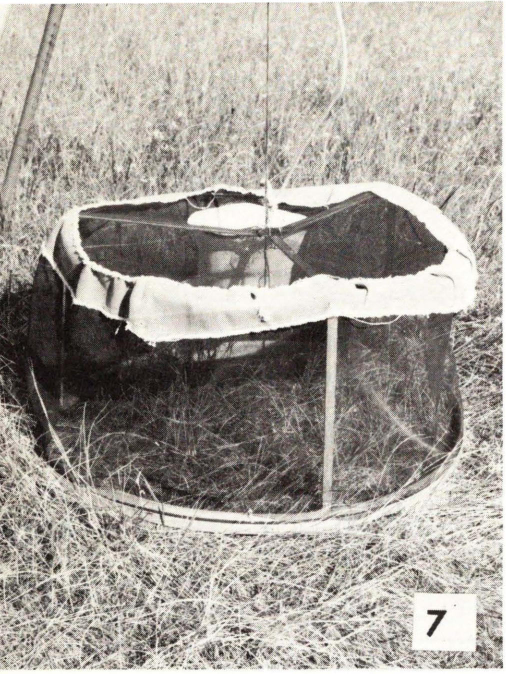
4—Jerrold L. Dodd, post-doctoral fellow with a Ph.D. from North Dakota State University, places a flag used as a marker to indicate exact spots for small experimental plots in a 5-acre area fenced off in 1963. Dodd works with all aspects of the South Dakota Grassland Biome study at Cottonwood but is especially concerned with herbage dynamics above- and below-ground.

5—Somewhat akin to lowering a flag to start a race, when these insect "quick-traps" are tripped and fall to the ground it signals a day of feverish field data collecting activity that culminates many hours of planning and coordination of several SDSU Agricultural Experiment Station departments cooperating in IBP investigations. Forty of these traps are used every 2 weeks throughout the summer when field samples are collected.

6—The quick-trap, after being suspended about 12 hours, is dropped by tripping the rope extending from the tripod top. The trap encloses a plot 0.5 of a meter square. Dave Rodgers has "pulled the pin" to demonstrate how the trap is lowered. Rodgers, of Valentine, Nebr., and a range management graduate of the University of Nebraska, is now a research assistant in SDSU's Animal Science Department.







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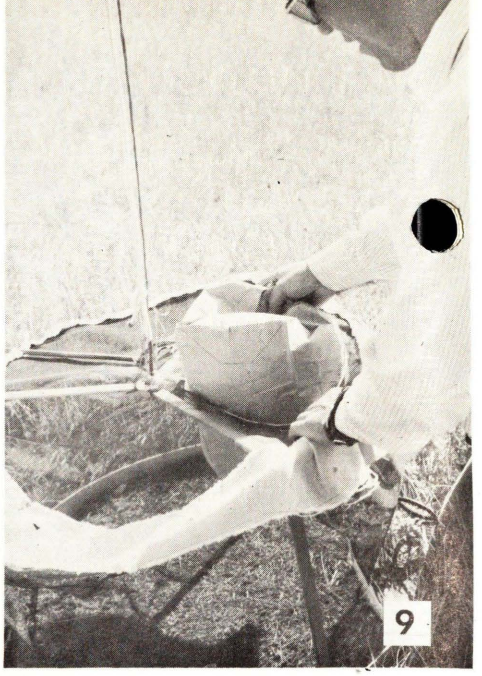

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provided a more detailed insight into range vegetation and production:

ABOVE GROUND

	High range condition	Low range condition
	lb/A	lb/A
Dominant plant	Western wheatgrass	Buffalo-grass
Peak community standing crop	1,800	1,100
Sum of peaks of individual species	2,350	1,400
Peak community plus estimate of decomposition losses	4,300	1,850

BELOW GROUND

	High range condition	Low range condition
Peak total weight, live and dead, to depth of 2 feet, lb/A	12,000	20,000
Peak mulch weight, lb/A	4,200	2,300
Max. Below:Above ground ratio	3:1	7:1

Nearly half (45%) of the total below-ground plant biomass was in the top 4 inches of soil in both high and low range conditions.

Students, 4-H Members Benefit

Additionally, IBP is giving important spin-offs for students. Graduate students, as well as some undergraduates, are receiving valuable experience and training in research and laboratory work — both inside and "outside" types. From another standpoint, some of the work provides part-time employment for students.

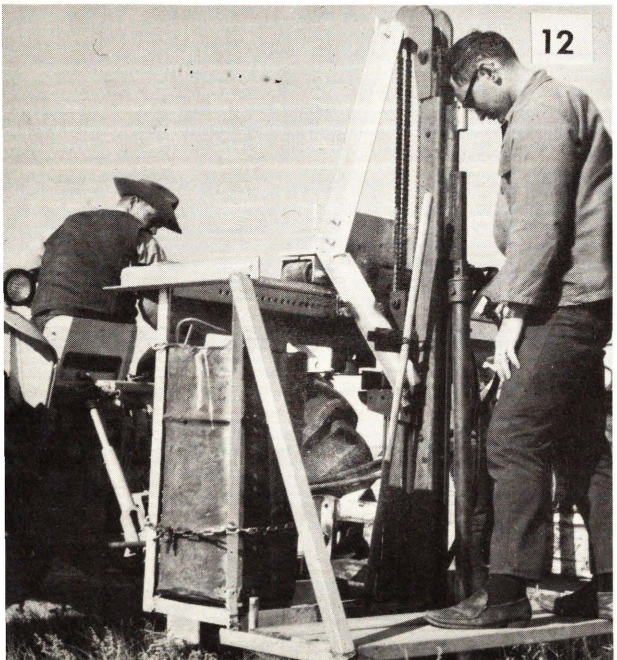
Then there are 4-H club members making use of results of the IBP investigations: 4-H members indicated an interest in the insects being identified in their community around Cottonwood. As close-up photographs of all the different insects were being made as a regular procedure to help train laboratory workers on the grasslands investigation, it was easy to prepare a similar photo identification manual for the 4-H'ers. Pinned specimens will also be prepared for them. Jerrold L. Dodd, post-doctoral fellow on

(continued on page 8)

Photo Series continued

7—The quick-trap is sprung and action begins. Materials are removed from inside the trap through an opening at the top. The vertical wire through the cage center is anchored at an exact, predetermined point on the ground and acts as a guide to prevent lateral movement when the cage drops.

8—Vegetation within the cage is cut with a special electric clipper by Dave Rodgers. Power is from a generator housed in an auto van which provides needed mobility for some of the equipment.



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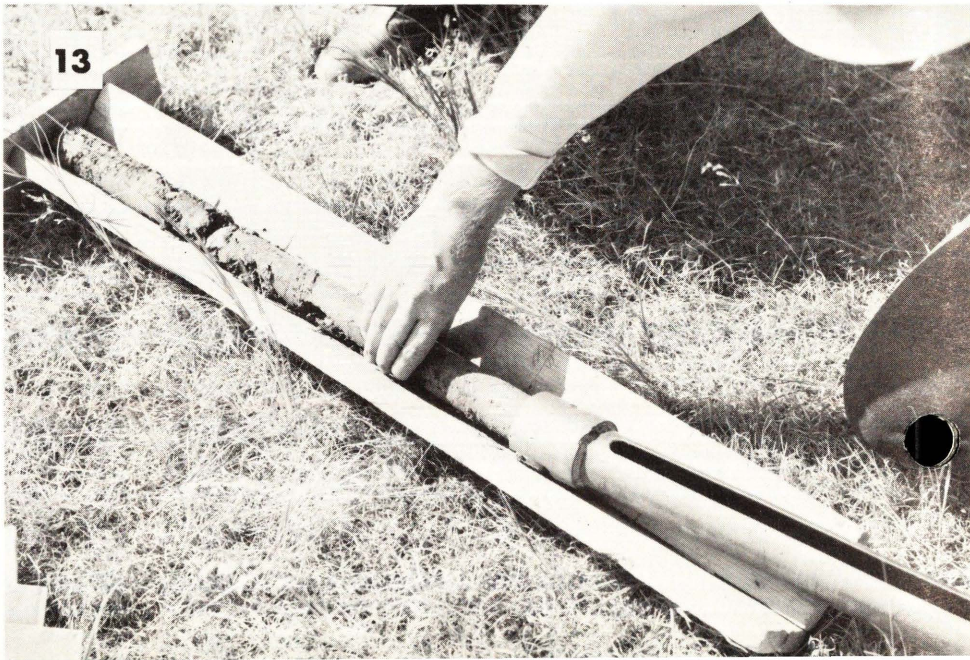

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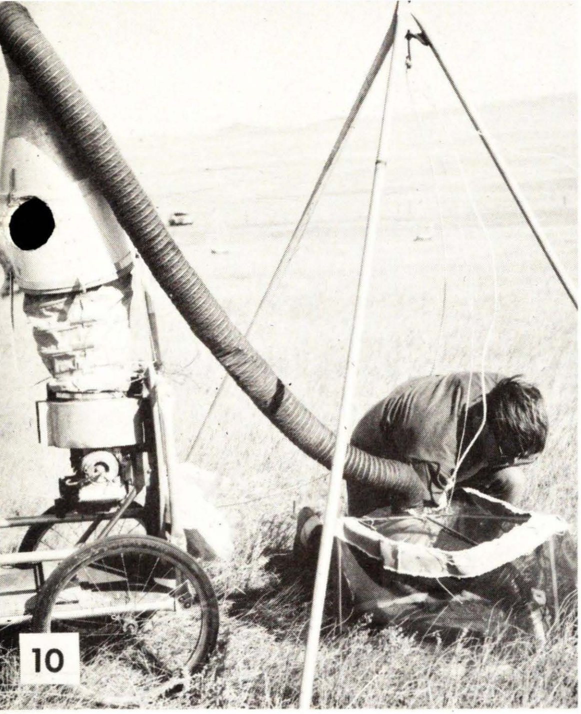


9—Clippings from each cage are placed in a sack—shown here being removed —which is labeled to designate the exact spot, date, treatment and replication. These plant materials and insects will be carefully catalogued during coming months.

10—After clipped plant material has been removed from the cage, the inside ground surface is vacuumed with a gasoline - powered vacuum-cleaner-like device called a DeVac. Insects and plant material (mainly mulch) are collected during this operation. Craig Anderson, an undergraduate entomology-zoology major from Brookings, mans the vaccuum here.

11—Bacteriologists next take over the small plots after cages are removed following collection of insect and plant materials. Jack Turner, former assistant in bacteriology, demonstrates to Mrs. Paula Hamm, research assistant in entomology, a method for measuring soil respiration as carbon dioxide released from an area of soil in a certain period of time. Turner is working toward a doctor's degree in microbiology at the University of Oklahoma. Mrs. Hamm, formerly of Lake Preston, is a graduate student in entomology who also does IBP work in the lab at Brookings.

12—Soil samples to a depth of about 2 feet are obtained from the same plot with this coring device mounted on a tractor. The samples are used to determine root biomass, soil moisture, nematode populations, and bacterial plate counts. Ronald Strangeland, Brookings, assistant in the Bacteriology Department, supervises the coring from a platform so as not to step on adjacent plots. Maurice Davis, Camp Crook, range technician in the Animal Science Department, operates the tractor.

13—Soil from the coring device is placed in a trough to facilitate dividing into small segments.

14—Segments of soil cores are carefully labeled, packaged in plastic bags, and frozen or refrigerated for later study. A special motor-powered root washer separates soil from roots. Preparing the samples here are: (rear, left to right) Maurice Davis, Ronald Strangeland, Mrs. Paula Hamm, Jack Turner, (front) Phyllis Schiwal, research assistant in entomology, and Margaret Graling, entomology-zoology lab technician. These girls work in laboratories in Brookings but visited the field site last summer to get a more comprehensive view of the project.

15—Rate of decomposition of plant material is determined by burying a series of small nylon netting sacks of grass in May and removing some each month for detailed study.


16


17

Grassland Biome studies at Cottonwood, helps the club members with their insect studies. Joe Herndon, Station superintendent, is a 4-H club leader.

Six Fields Represented

SDSU scientists participating directly or indirectly in the IBP are from these fields: range management, animal science, entomology-zoology, bacteriology, botany-biology, and plant science.

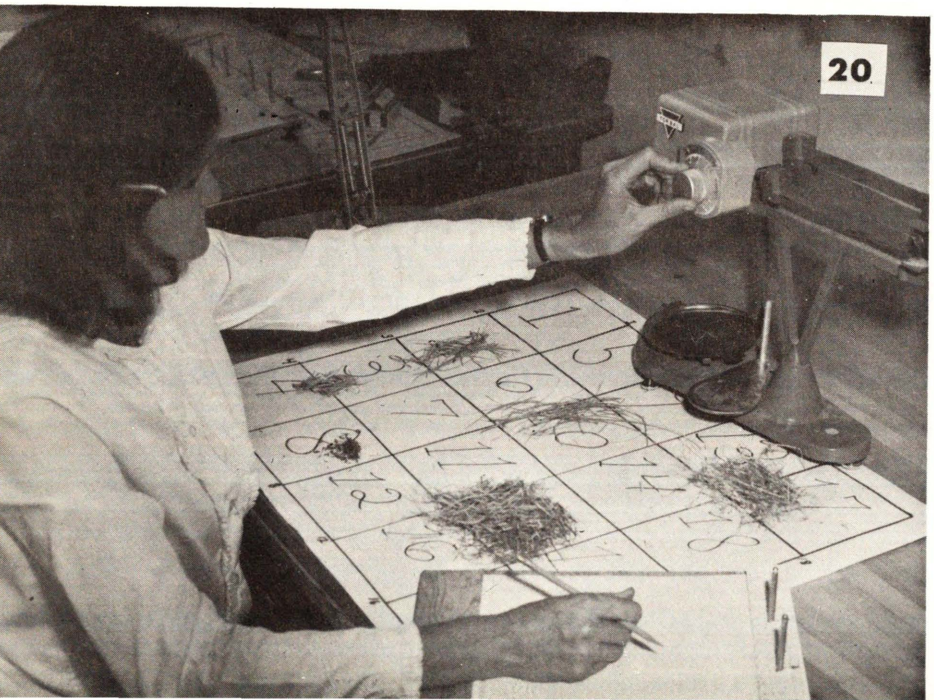
The Grassland Biome subprogram provided a grant of $39,500 to SDSU for IBP activities last year, Lewis explains. These funds were supplied by the National Science Foundation through grant GB 13096, U. S. IBP Grassland Biome. Some activities of staff as well as part-time student employment were funded from this grant, he adds. Other staff members participated in the coordinated effort somewhat "on their own"—some even at night and on weekends—so that time was not taken from their regular SDSU assignments.

Measurements made or data collected periodically from each of the exclosures at Cottonwood involves such things as herbage above and below ground, including mulch and roots; soil respiration (CO_2 release); bacteria, streptomyctes and fungi decomposer activity; insects above and nematodes below ground; climatic factors such as precipitation, evaporation, wind movement, soil temperatures, soil moisture, solar radiation, and relative humidity. Laboratory work involves thousands of analyses, tests, and identifications.

Remote Sensing, Too

As the Grassland Biome people from SDSU were on the Cottonwood site gathering data, the Remote Sensing Institute last summer made data-collecting flights to get aerial photography information for use in connection with this source of "ground truth." Also involved in the RSI information gathering was the Plant Science Department mobile research lab which was set up

(concluded on page 10)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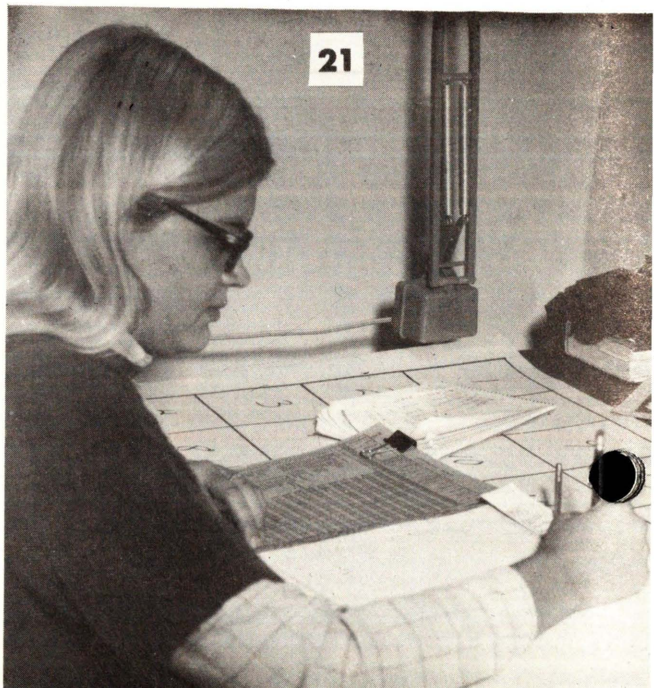
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Photo Series continued

16—This "litter bag" is removed after being buried for several months. The string at right is a permanent marker to aid in locating the spot where the bags were buried.

17—In addition to the Grassland Biome research, the Cottonwood site frequently is used as an outdoor laboratory stop for SDSU student field trips. H. L. Hutcheson (right), associate professor in the Botany-Biology Department, demonstrates the operation of a quick-trap to plant ecology students on a field trip to to the Black Hills. Dr. Hutcheson is part of the Cottonwood research team, specializing in below-ground plant biomass.

18—Watershed and evapotranspiration studies are also conducted at Cottonwood by the Agricultural Research Service, USDA, under the direction of Clayton Hanson, agricultural engineer of Rapid City, who is also part of the research team. A. J. Herndon, superintendent of the Cottonwood Range Field Station, checks a recorder on one of the experimental watersheds.

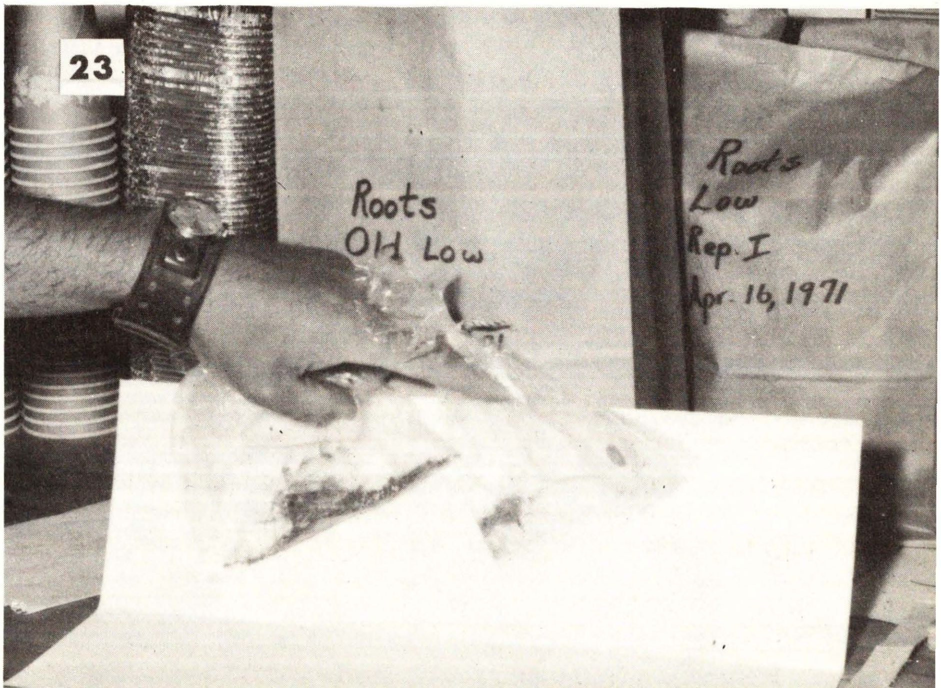
19—Ruby Herndon, technician from Cottonwood, identifies and estimates the weight of above-ground plant material in the on-site laboratory at the Range Field Station.

20—Weight estimates are calibrated by carefully separating and weighing parts of the larger samples. Mrs. Herndon weighs separated herbage samples from one of these parts on a gram balance.

21—The small, but well-equipped on-site laboratory building at the Range Field Station was converted from an old chicken house for use in the IBP investigations. Julie Weber, technician from Philip and a former SDSU physical education major, records data on computer forms to permit rapid summarization and evaluation.

22—Soil core samples from various depths are "washed" in this motor-driven device to remove plant roots. Fine-screens at top and bottom of the sample container (shown here being removed) prevent loss of root material when the container is moved in an up-and-down action through water in the buckets. Each of seven depth increments from a single core can be washed at the same time.

23—After soil samples are thoroughly "washed" in the root washer, the roots are dried at low temperature, weighed and ashed. The sample in the plastic bag on the left is from a 0- to 2-inch depth, the right sample from a 20- to 24-inch depth.



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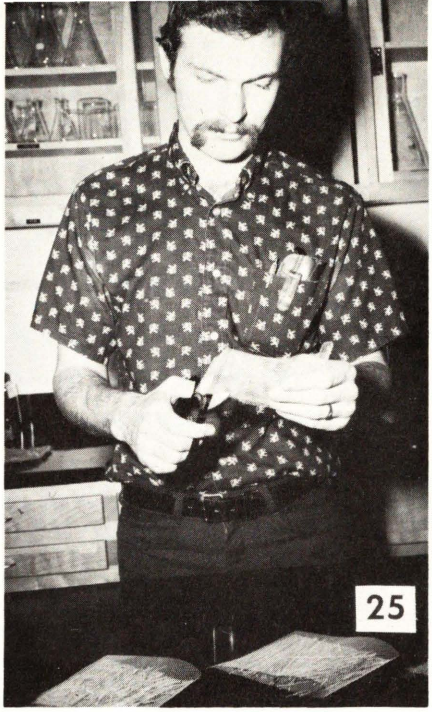

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26

briefly at Cottonwood. The area is also used as part of a "range" for Grassland Biome studies of mammals by the University of Kansas and of birds by Oregon State University.

In addition, other Agricultural Experiment Station and USDA-ARS research continues. Runoff from grazed watersheds and evapotranspiration rate as affected by range condition are being measured by Clayton Hanson, of ARS at Rapid City. The Cottonwood pastures are used to measure cattle diets and livestock production as affected by range condition. In winter, liquid and natural protein supplements are compared using steer calves grazing winter range. In drylot, non-protein nitrogen supplements are studied with prairie hay rations. Range improvement plots are still being observed and a new grass and range plant nursery is being established.

Visitors are welcome at the "outdoor lab" at Cottonwood.□

Photo Series continued

24—Back in Brookings during the winter. Here in a bacteriology lab Diana Mortenson cuts 4-inch sections of plant material ("litter") collected from the Cottonwood Grassland Biome site in 1970. This starts preparation of the litter bags to be buried at Cottonwood in 1971. Miss Mortenson is a junior medical technician at SDSU from Howard.

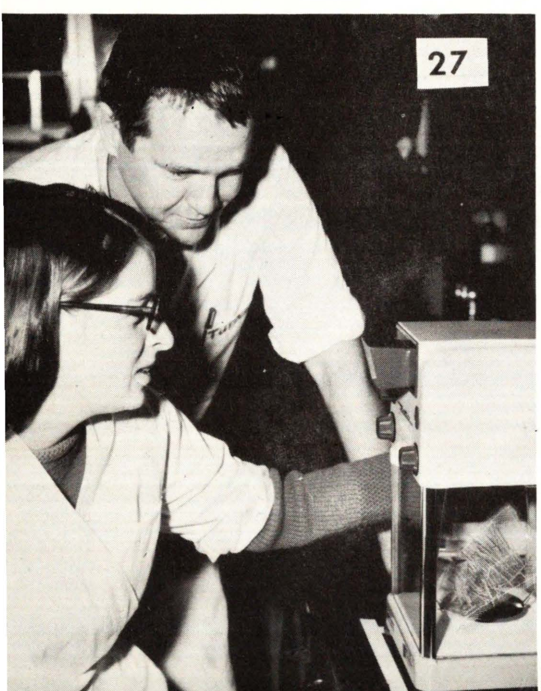
25—Jeffry Kohlhoff cuts nylon netting used to make the litter bags which are slightly less than 5 inches square. Unsewn bags filled with last summer's litter are on the table. Kohlhoff is a junior bacteriology student from Leola.

26—A sewing machine in a bacteriology laboratory? In this case Linda Buseman uses one to sew the litter bags which will be buried at Cottonwood this summer. She first makes a seam through the center to anchor the litter and then sews around the edges to close the bag. Miss Buseman is a senior nursing student from Chancellor.

27—Jack Turner watches Diana Mortenson carefully weigh a litter bag before it is finally tagged with a number, ready to be buried in the Grassland Biome site at Cottonwood. Weighing is one of the first procedures when the bag is recovered.

28—A battery of berlese funnels at the Cottonwood lab separates and preserves small insects from the ground litter samples. The litter sample is placed in the container (opend by Jerrold Dodd for demonstration), heat from the electric light causes insects to move down into the funnel and into the small glass jar containing alcohol. Jars are sent to Brookings where the insect specimens are identified and counted.

29—Mrs. Paula Hamm, who does much of the direct insect identification in the entomology-zoology lab at Brookings, is also part of a "team" that takes insect



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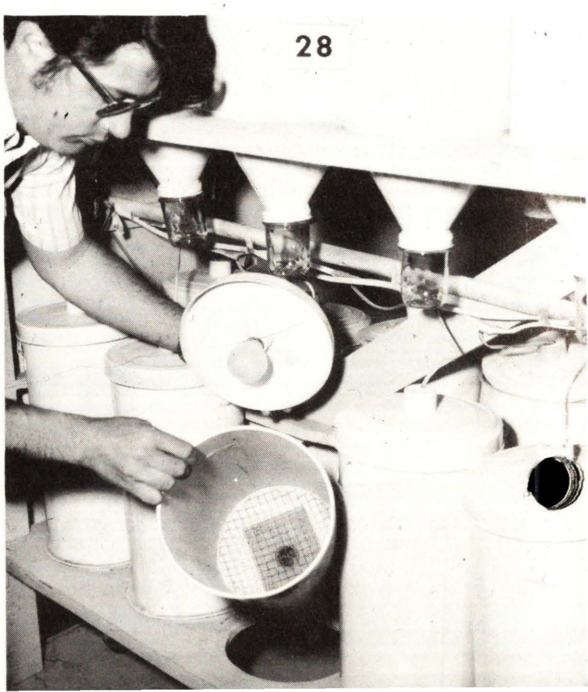


28

In addition to livestock...

Another Consumer on the Range

BEEF cattle *and* a pinhead-size sap-sucking insect are the *two* greatest consumers of grass over a vast South Dakota grassland area.

In fact, on a per-acre basis, the previously-unrecognized scale insect is at least equal to and perhaps surpasses cattle when it comes to using grass as feed, say South Dakota State University scientists.

The insect didn't just suddenly swoop down to destroy grassland forage production worth millions of dollars. It has been there all along. Only within the past year, however, has its importance in the grassland ecosystem been recognized. Preliminary evaluations indicate the insect, believed to inhabit much of the Northern Plains grasslands, consumes more plant sap on a per-acre basis than beef cattle grazing at a proper stocking rate. However, the actual effect on total grass growth is not known.

Mealybug Causes Damage?

Commonly known as the mealybug, the insect's importance in western South Dakota became known in an early research spin-off near Cottonwood under which South Dakota State University is cooperating with the Grassland Biome subprogram of the International Biological Program (IBP). IBP is a worldwide effort involving more than 50 countries concerned with the biological basis of productivity and human welfare (See other articles and photographs in this issue).

In 1968 Agricultural Experiment Station entomologists reported mealybugs on buffalograss and blue grama in South Dakota east of the Missouri River. The research effort was then extended westward and, says the project leader, "meshes almost exactly" with a portion of the South Dakota phase of the Grassland Biome subprogram.

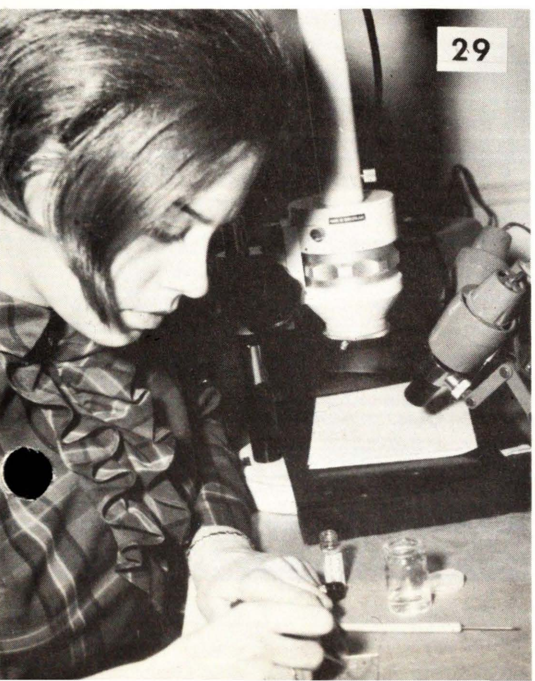
"Apparently this mealybug has been here a long time but because it is so tiny we didn't realize it consumed so much sap," says Burruss McDaniel, who is in charge of South Dakota IBP insect investigations and leads the Agricultural Experi-

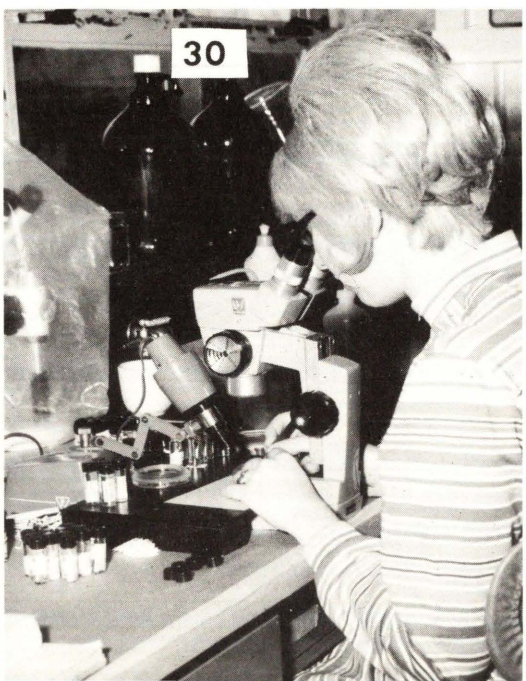
(*continued on next page*)

photographs used to train others in identification procedures. Her husband, David Hamm, a wildlife graduate student, is the other photography team member. Both Mr. and Mrs. Hamm did undergraduate work at the University of Missouri.

30—Peering into a dissecting microscope counting and identifying insects collected at Cottonwood last summer is the job of Margaret Graling, an entomology-zoology lab technician. Each of the small bottles (at her left) contains insects collected last summer from just one of the many 0.5 square meter quick-trap plots. Miss Graling, of Brookings, is a SDSU zoology graduate of last spring.

31—Actually, the field collection of material and data at the Range Field Station in the summer is only a fraction of the work that goes into the effort at SDSU in the IBP Grassland Biome contributing project. Aside from all the technical work, just keeping accurate track of the hundreds of samples themselves is a major activity. Gary Wheeler, a junior wildlife student from Arlington Heights, Ill., re-labels small bottles containing insects collected last year.





ment Station research project. He is an associate professor in the Entomology-Zoology Department at SDSU.

Insects Consume Sap from Grass

Mealybugs may cause injury by extracting plant sap (phloem) and by excreting honeydew, which can form a medium for the growth of various species of fungus. They generally live in the crowns of plants with buffalograss and grama grasses being their favorite South Dakota diet. Populations of the insects are believed to be smaller in eastern South Dakota than in the western part of the state.

Based on research data obtained at the Cottonwood Range Field Station last summer and evaluated throughout the winter, the mealybugs were right up there with cattle as range consumers, according to estimates by Dr. McDaniel and James K. "Tex" Lewis, associate professor in the Animal Science Department who is in charge of the SDSU contributing project to the comprehensive Grassland Biome phase of IBP. Here is how they figure it: on the basis of normal stocking rates, a cow will eat about 250 pounds of dry matter (grass) an acre per month. A single mealybug consumes phloem or sap from grass plants at a rate of about 1 gram a month. This isn't much on a per-mealybug basis — 1 gram weighs slightly less than 2 drops of water—but when the amount is multiplied by huge populations of the insect and converted to dry matter relationships it at least equals the amount a cow would eat.

Cattle on a large acreage of South Dakota grasslands must share range forage with numerous insects, one of the most important being the mealybug. These cattle are in an experiment at South Dakota State University's Range Field Station, 2 miles east of Cottonwood and about 11 miles southwest of Philip.

Combination May Kill Grass

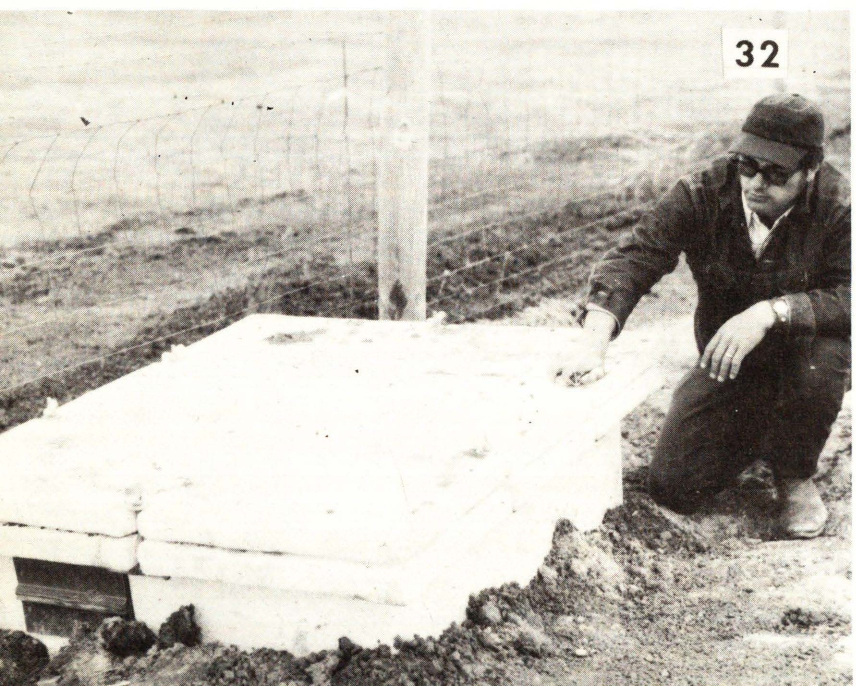
"A combination of drought, overgrazing and heavy mealybug populations can cause more damage than just loss of a goodly amount of forage—it can kill the grass," says Dr. McDaniel, who formerly worked in Texas where another species of this scale insect has been of considerable economic importance for more than 50 years. "In fact, some ranchers often blame drought entirely for areas or spots of dead grass on their range when actually overstocking, high mealybug populations and dry weather combine to kill the grass. Where a suitable stocking rate is followed these scale insects aren't so important although the rancher has to share some grass with them.

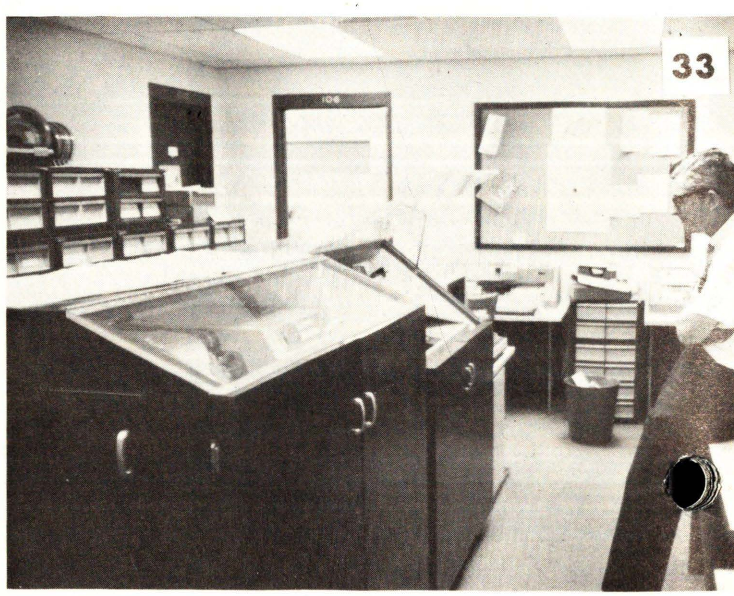
What can be done about the mealybugs?

"They may not be harmful but if they are about the only thing to do is what range management people have been pushing for all along (but for another reason)—keep the range

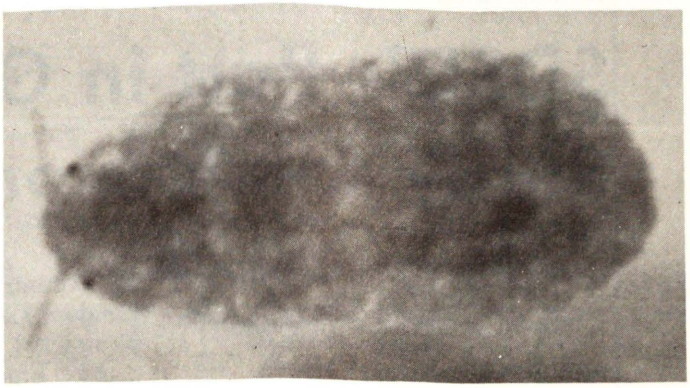
Photo Series continued

32—This buried container, part of a micrometeorological data package at Cottonwood, will house instruments that automatically record data for the following: precipitation; wind; total and net radiation; soil moisture at two depths; air moisture at maximum canopy height; air temperature at three heights; soil temperature at three depths; soil heat flux. The "package" puts all data on a tape system which is periodically sent to Grassland Biome headquarters for computer analysis.





in high condition," says Dr. McDaniel. "We found that the mealybug populations in low condition range were about twice as high as populations in high condition range. This was because the high condition range was also populated with more of their predators or enemies."



A greatly enlarged photo of an individual mealybug from Cottonwood. Although actual size is smaller than a pinhead, huge populations feeding on sap from grass plants make the insect a major "consumer" on the range.

Counted by the Thousands

Some 1,100 mealybugs were counted in samples taken in May from a range area about as large as a good-sized room. By September, 20 times more mealybugs were present, the booming population being based on an actual count of 11,166 in an area half the size of that used in the May sampling, according to the SDSU entomologist.

"Control of these scale insects with chemicals is out of the question," the SDSU entomologist states emphatically. "Even if we had a suitable chemical without residue problems, it would not be feasible to treat millions of acres which we believe are involved. Besides, it would be difficult to reach the insect with sprays because of its method of feeding down in the plant crowns."

Otherwise, about the only thing to do right now is for the range livestock producer to maintain high range condition and resign himself to the fact that he's contributing a large amount of plant sap to an inconspicuous bug which has a total effect as yet not fully known.

From another standpoint, application of an insecticide would likely kill mealybug predators and cause other changes which could upset or alter the delicate balance of an ecosystem which apparently has been built up naturally for a long time. This would likely result in very great losses, the SDSU scientists point out.

Learning about Ecosystems

"After all," Lewis adds, "we must understand how the ecosystem is put together and how it functions so that we can design optimum management systems. Understanding ecosystems as a basis for management is at the heart of the Grassland Biome effort."

SDSU investigators believe research to understand the ecology of mealybugs will pay for itself many times over because of their importance over such a large area. With use of chemicals practically ruled out, at least under present circumstances, researchers will concentrate on regulating or encouraging natural parasitic and predator enemies of mealybugs. Such biological controls are difficult to establish and tricky to manage, although Dr. McDaniel says some headway has been made in Texas where several types of parasites have been imported to combat the mealybugs.

This summer Dr. McDaniel will headquarter in the western part of the state as the South Dakota spinoff from the IBP investigation concentrates on learning more about the relationships of mealybugs and their natural enemies plus studying the specifics regarding plant species and distribution.□

33—Dr. Jack Gross of Colorado State University, who works with jackrabbit population models, watches results of his data from a CDC-200 series terminal with reader-printer and cathode ray tube console hooked to a CDC-6400 computing system. Information from the grassland biome studies at Cotttonwood and elsewhere are processed by this computing system. These data will also be used in the formulation and testing of mathematical models to help predict the effect of man's manipulation of the ecosystem. (Photo courtesy Environmental Resources Center, CSU.)

34—SDSU staff members taking part in the Grassland Biome studies include: James K. Lewis (seated), Animal Science Department who is in charge of the South Dakota phase of the project; (standing, left to right) Edward S. Olson, Botany-Biology Department; Robert M. Pengra, Bacteriology Department; H. L. Hutcheson, Botany-Biology Department; Burruss McDaniel, Entomology-Zoology Department; and James Smolik, Plant Science Department.

South Dakota in IBP

SDSU's Part in Global Study Centers on Range

By
J. K. "Tex" Lewis,
associate professor of animal science,
Agricultural Experiment Station,
South Dakota State University,
and
leader of the SDSU contributing project to the Grassland Biome Subprogram of the U. S. IBP.

THE ENVIRONMENTAL crisis is forcing man to accept the concept that the earth is a spaceship, a tiny, speck of the universe containing limited resources. With a massive and growing population and expanding technology, ecological wisdom is required if man is to survive very long on this plant.

One research approach to understand and meet the problem is the International Biological Program (IBP), which is to biological aspects of the earth what the International Geophysical Year (IGY) was to geological aspects of the world in 1958. South Dakota State University, among dozens of universities in the United States and abroad, is performing a part in this worldwide effort.

The Scientific Committee which coordinates projects of more than 60 countries headquarters in London, England. It has seven International Sections:

- (PT) Productivity of Terrestrial Communities.
- (PP) Processes of Production.
- (CT) Conservation of Terrestrial Communities.
- (PF) Productivity of Fresh Water Communities.
- (PM) Productivity of Marine Communities.
- (HA) Human Adaptability.
- (UM) Use and Management of Biological Resources.

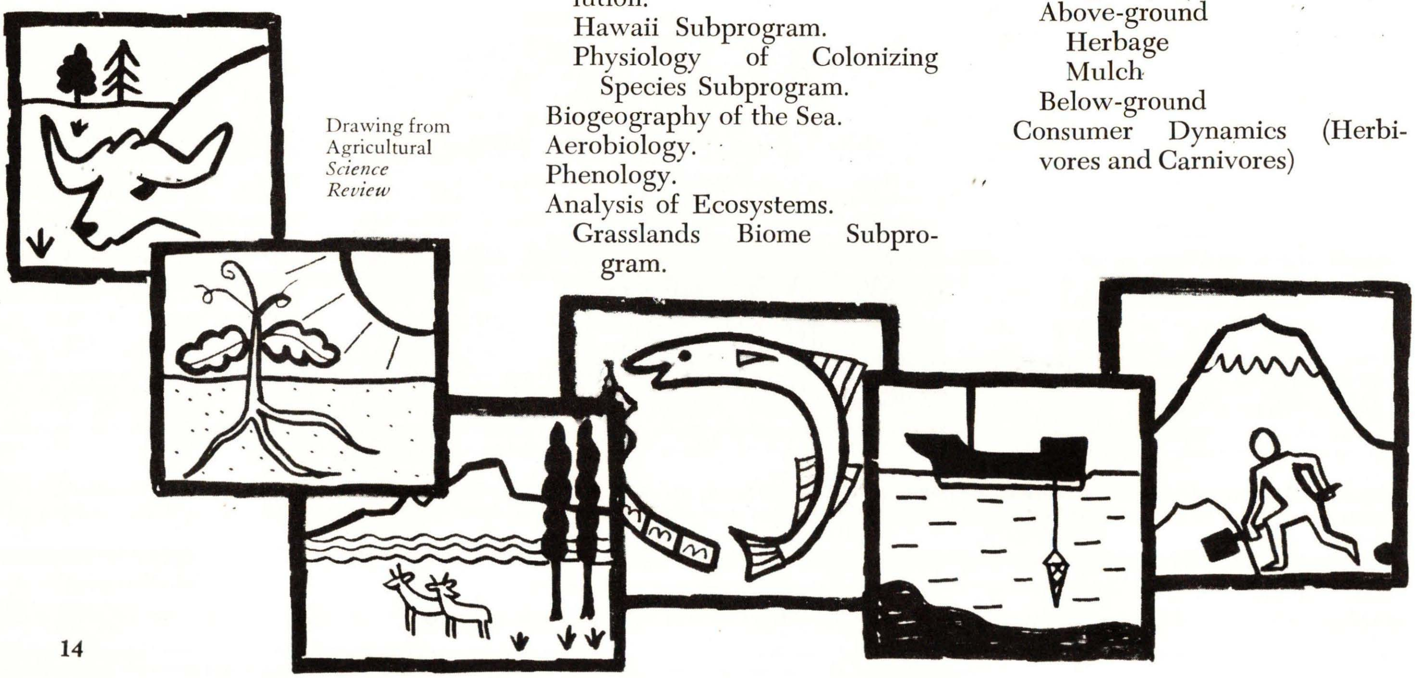
The United States has various Integrated Research Programs coordinated with each of these committees. Overall, the U.S. effort looks like this:

- International Studies of Circumpolar Peoples.
- Population Genetics of the American Indian.
- Biology of Human Populations at High Altitudes.
- Nutritional Adaptation to the Environment.
- Biosocial Adaptation of Urban and Migrant Populations.
- Convergent and Divergent Evolution.
  - Hawaii Subprogram.
  - Physiology of Colonizing Species Subprogram.
- Biogeography of the Sea.
- Aerobiology.
- Phenology.
- Analysis of Ecosystems.
  - Grasslands Biome Subprogram.
  - Deciduous Forest Biome Subprogram.
  - Coniferous Forest Biome Subprogram.
  - Tropical Forest Biome Subprogram.
  - Desert Biome Subprogram.
  - Tundra-Taiga Biome Subprogram.
- Conservation of Environments.
- Biological Control.
- Biology of Upwelling Ecosystems.

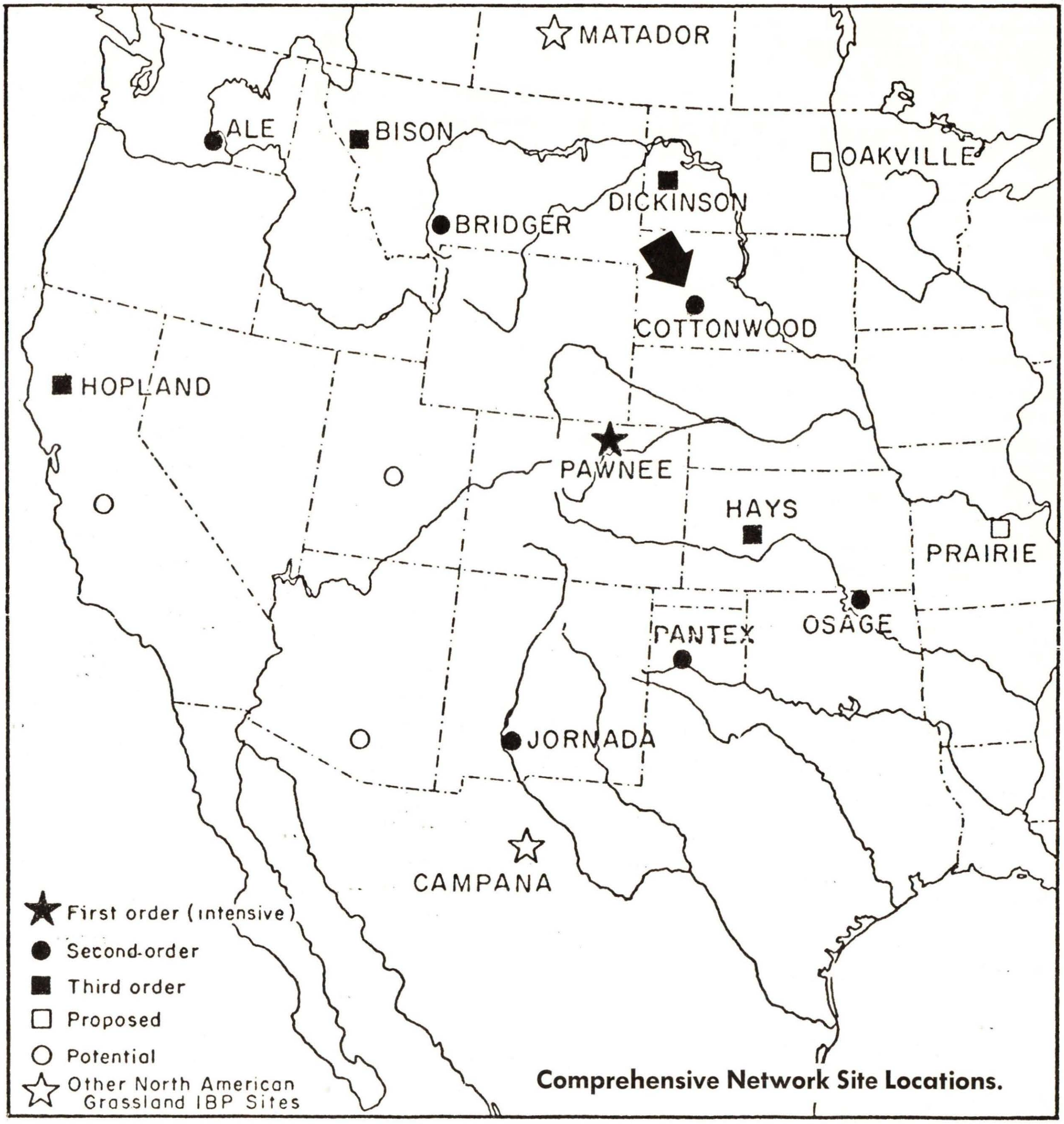
SDSU is involved in the Grassland Biome Subprogram under the Analysis of Ecosystems Integrated Research Program. The grassland study is of special interest to range managers and users. Headquarters for the Grassland Biome is at Colorado State University, Fort Collins, with intensive research facilities at Pawnee, in north-central Colorado, where in 1970 some 38 scientists from eight organizations worked in 13 subject matter areas. This is termed a "first order" site.

"Second order" sites (see map) were established in 1970 and included the one at the South Dakota Agricultural Experiment Station's Range Field Station, 2 miles east of Cottonwood and 75 miles east of Rapid City. Second order sites collect this type of data:

- Abiotic Data.
  - Climatic
  - Microclimatic
  - Soil
- Herbage Dynamics
  - Above-ground
    - Herbage
    - Mulch
  - Below-ground
- Consumer Dynamics (Herbivores and Carnivores)



Drawing from Agricultural *Science Review*



Comprehensive Network Site Locations.

Invertebrates
Small Mammals
Birds
Decomposer Activity

At Cottonwood the research is part of the overall effort to understand energy flow and nutrient cycling in a grassland ecosystem. The idea is to know how much energy is fixed in photosynthesis and how it is used—or, essentially, in unscientific terms, "what eats what," ranging from bacteria to birds, from a mealybug to a cow. Plant growth is the base of the food chain, depending upon photosynthesis to exceed respiration. The total net plant production can be determined either by measuring the total amount present (above, below and on the ground) and accounting for the losses or by continuously measuring photosynthesis and respiration (a method which is not practical for range studies). The researchers also want to know how this energy flow is affected by grazing management and weather.

Although not stressed at Cottonwood, ecosystem research also involves studying how nitrogen (or other substances) is fixed and taken up by plants and how it is passed along the food chain or excreted and recycled into the atmosphere.

In addition to understanding how grassland ecosystems are put together and how they work, Grassland Biome reseachers are trying to describe them using mathematical equations. To do so requires an understanding of the important processes that go on in the grassland. The resulting "model" provides a framework to summarize what has been learned. When and if such a "mechanistic model" is perfected, it will provide tremendous insight into how to manage a grassland. For example, various weather conditions and various management treatments can be introduced as variables, the model run through the computer, and results obtained which will be very close to real life situations.□

Questions /Answers

Narrow Rows for Corn

By
F. E. Shubeck and D. B. Shank
Dr. Shubeck and Dr. Shank are both professors in the Plant Science Department of the Agricultural Experiment Station.

Selecting a Variety

Q. Is it really very important to select a special variety just for narrow rows?

A. Opinions vary, but our data for South Dakota suggest that it is important. Figure 1 shows that yield increases due to narrowing rows varied from 3.2 to 6.2 bushels per acre depending on the hybrid selected. These differences were highly significant.

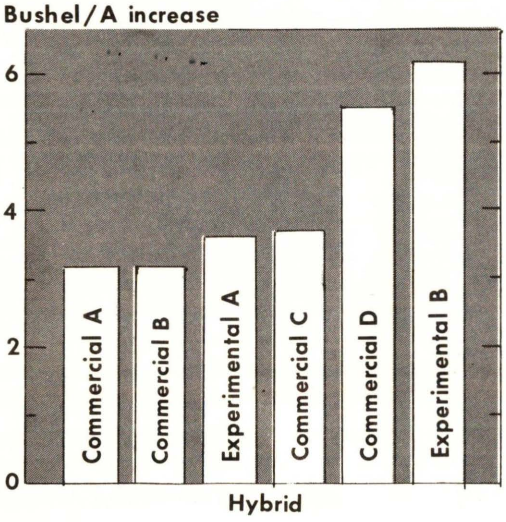
Q. Were these hybrids in the same maturity range?

A. In this test, ear moisture at harvest varied from a low of 17.5% to a high of about 20%. This would be equivalent to about 4 to 5 days difference in maturity between the earliest and latest hybrid used in the experiment.

Q. Do you have a comparison of hybrids with wider differences in maturity?

A. Yes, but then plant densities become a more important factor.

Figure 1. Yield increases from different hybrids due to narrowing rows from 40 to 30 inches (average of 12,000 and 16,000 plants/acre).



Earlier hybrids usually have smaller ears so a greater number of plants and ears are necessary to maintain yields comparable to those from bigger, later hybrids. The early short season hybrid in Figure 2 was about 7 to 10 days earlier than the late full season hybrid. Notice the difference in yields between the two hybrids when an inadequate stand of 10,000 plants per acre was used. At 18,000 plants per acre, the short season hybrid yielded almost as much as the bigger, later hybrid.

Q. Is it possible to find a row spacing and population combination for early hybrids that will yield more than the late hybrids?

A. More research is being done on this possibility but past results suggest that it is pretty difficult to beat full season varieties for maximum yield when they are planted at their best individual row spacings and populations.

Q. Some hybrids have a more erect type of leaf growth. Are these hybrids better adapted to narrow rows than the old familiar inverted U-leaf pattern?

A. Theoretically, plants with more erect leaves can stand crowding better because more sunlight can pentrate through the leaf canopy to reach middle and lower leaves.

Q. Are there any experimental results to prove this?

A. Results from a California study indicate that leaf area must be greater than approximately three times the ground area before upright leaves will become a very important factor.

Q. With the size of hybrids that we can mature in South Dakota and with the number of plants that our average rainfall can support, can we exceed this leaf area and expect yield increases to develop from hybrids with uptilted leaves?

A. At the Southeast South Dakota Experiment Farm, with 18,000 plants per acre and a full season hybrid, leaf area was 3.4 times that of the ground area. Therefore we could expect only a small yield advantage in favor of upright leaves with similar populations and size of hybrids. Under irrigation, with more plants per acre and a greater leaf area, the advantage for upright leaf hybrids would probably be greater.

Q. Should greater emphasis be placed on disease resistance and insect tolerance when selecting a hybrid for narrow rows?

A. Information on this point is not clear-cut in regard to narrow rows. It is fairly definite in regard to plant population densities. With high population densities, stress on plants due to competition for moisture, nutrients, and sunlight tends to weaken plants and increase susceptibilty to damage from certain diseases and insects. One of the most damaging disease problems in experimental plots has been stalk rot in fields with high plant populations.

Q. Most farmers like to see big ears going into the wagon at picking time. Tell me, do big ears always mean more bushels per acre?

A. Not always. If ears are very large, it means that there were not enough plants to use all of the moisture and nutrients that were available. Attempts have been made to relate ear size at harvest to optimum plant densities.

Figure 3 shows that for the good growing conditions of 1965 a plant population of 16,000 an acre gave an ear size of 0.58 lb. at harvest and 109 bushels per acre. An ear size of 0.63 lb. at 14,000 population gave a yield just about as much.

Q. What would the relationship be with conditions more or less favorable than in 1965?

A. With better conditions yield did not drop as populations were increased from 16,000 to 18,000. Yields went up. With better conditions, ear size at 18,000 population increased about 0.08 lb. compared to 1965 results.

With less favorable conditions yields began to fall with populations over 14,000. Ear size also became relatively smaller with increasing populations.

Q. The curve in Figure 3 shows yields for a short season corn. Would a bigger full season hybrid have a similar curve relating yield to ear size and populations?

A. No. There would be less curvature in the line indicating yield. In a year with good growing conditions, the full season hybrid yield line was nearly flat with very little curvature indicating that yields were about the same regardless of the populations used. This is because the large hybrid partially compensates for a reduced stand by producing larger ears.

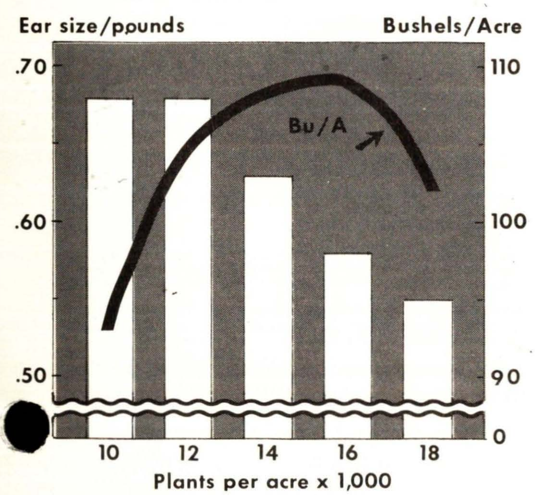
Q. Then yield of earlier corn is more sensitive to population variables?

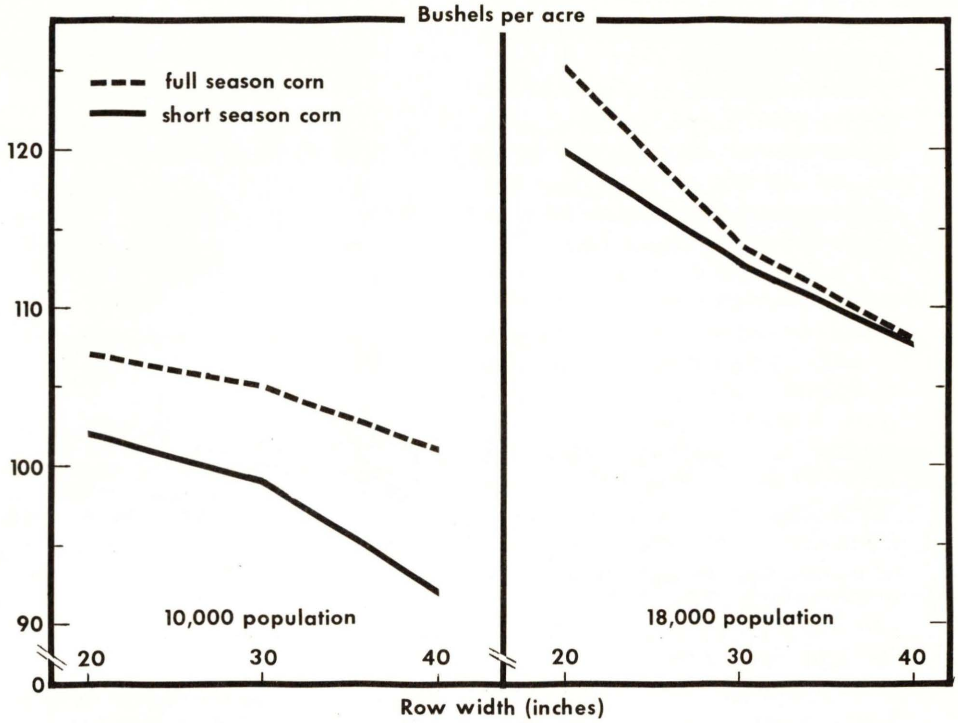
A. Yes, the bigger corn can compensate for insufficient stands better than the smaller early season varieties. This compensation ability is sometimes designated by the name of "ear-flex." You might be hearing more about "ear-flex" and "flex-range" as research continues.

Q. If I plan to plant early should I select a full season hybrid or a short season hybrid to plant first?

A. Some farmers plant early corn first and late corn last in order to lengthen the picking season and reduce field losses during harvest.

Figure 3. Relation of plant densities and ear size to bushels per acre in short season corn (1965).





This will help reduce harvest losses but is questionable whether or not it will result in a greater amount of corn in the crib.

An early maturing corn is usually smaller in leaf area and yield potential than a full season corn. If an early variety is planted very early it gets another reduction in leaf area and yield potential due to the very early planting date as shown in Figure 4. This reduction in leaf area was associated with a 10-11 bushel decrease in yield at the Southeast Research Farm. Therefore, for maximum production per acre, plant the biggest latest corn first and the short season varieties last unless your field losses due to all varieties ripening at the same time exceed 10-11 bushels per acre.

Notice in Figure 4 how the moderately early (May 9) and midseason (May 20) planting dates gave the most bushels per acre.

Q. I see that the June 3 planting had the greatest leaf area but not the greatest yield of corn. Could you explain this?

A. Late plantings always gave taller plants and a greater leaf area. In this case a bigger leaf factory was made to manufacture carbohydrates but it just ran out of time before frost killed the factory.

Figure 2. Effect of row spacing, hybrid and plant populations on corn yield, 1966. (Southeast South Dakota Experiment Farm.)

Narrow Rows In a Dry Year

Q. I understand that in experimental plots your average yield increase from narrow rows has been about 8% with total yields about 100 bushels per acre. What could we ex-

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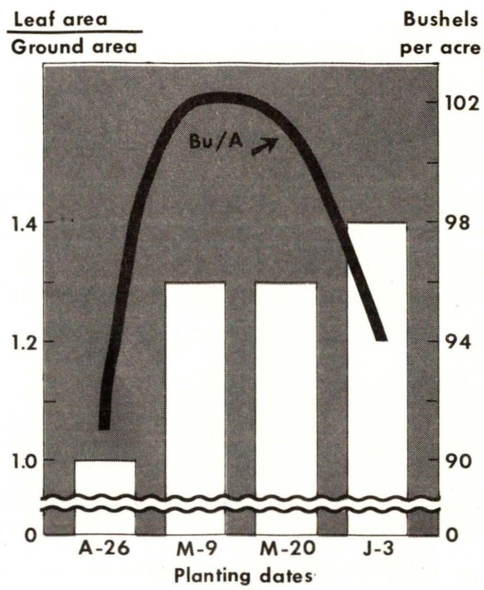
Figure 4. Effect of planting dates on leaf area, SE Farm 1968.



pect in years or areas where rainfall is not so favorable.**

A. At the Southeast Farm in 1970, dry weather reduced yields down to 40 bushels per acre. Rainfall in the critical months of June, July and August was 5 inches below average. Consequently, yield increases due to narrow rows were not so spectacular. The most interesting thing about results from this one dry year was that actual yield increases due to narrow rows were less than in more favorable years, but the percentage increase was about the same. Example: 8 bushel increase divided by 100 bushels per acre=8% increase in a good corn year compared to 3 bushels increase divided by 40 bushels per acre=$7\frac{1}{2}$% increase for narrow rows in a less favorable year. For this year, it looks as though a reduction in yield due to drought was accompanied by an associated reduction in expected yield advantage for narrow rows but the percentage increase remained about the same as for the better years.

Q. I can see that narrow rows were reasonably effective in a dry year but what about plant population densities? If a farmer planted enough plants for an average annual precipitation of 25 inches and received only 20 inches how badly would he get hurt in total yields?

A. In 1970 yields began to fall with populations over 14,000. As populations were increased from 14,000 to 20,000, yield of the big, late hybrid dropped 32% and the smaller early hybrid's yields dropped 18%.

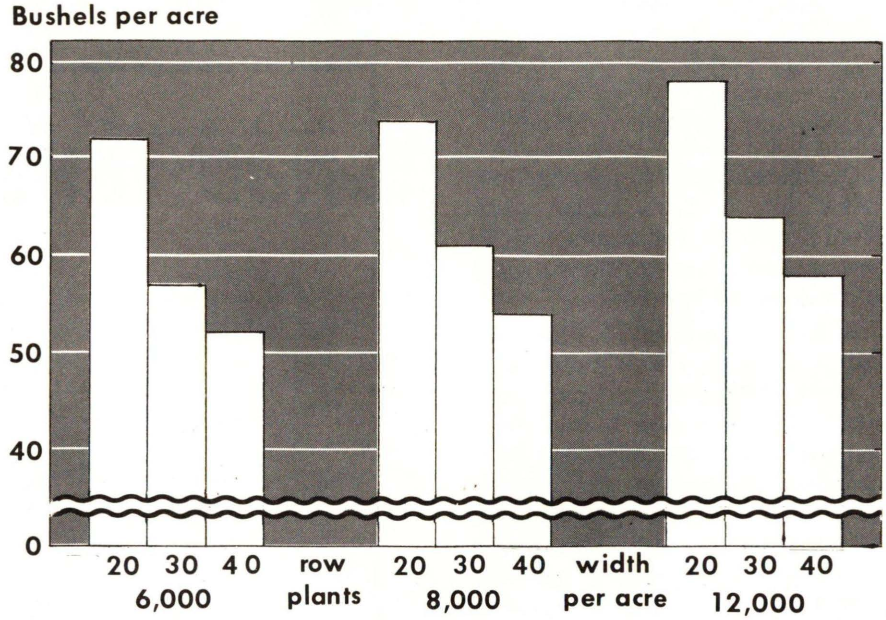


Figure 5. Effect of row spacing and plant populations on yield northwest of the South Dakota Corn Belt.

Narrow Rows in Northwest Area of South Dakota's Corn Belt

Q. What kind of response to narrow rows can we expect in northern and western areas of the South Dakota corn belt?

A. In 1970, which turned out to be a pretty good corn year for the area, results at the North Central Substation near Eureka were very definitely in favor of narrow rows.

There were highly significant differences in yield due to row spacing and to populations. The narrowest rows and highest populations were the best performing combinations for 1970. With climatic conditions less favorable, optimum populations will probably be less than 12,000.

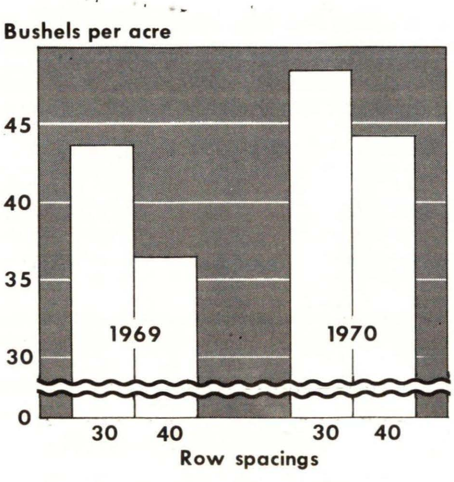
Apparent differences between hybrids used in this test were not statistically significant.

Narrow Rows in Northern Part of South Dakota's Corn Belt

Q. Do narrow rows make corn more competitive with flax and small grains in northern areas of the state?

A. Any practice that increases corn yields such as narrow rows would make corn more competitive with these crops. Two year's results from the high prairie coteau north of Watertown show that narrow rows were successful in increasing yields of corn when produced under the short growing season which characterizes high altitudes in the northern area.

Figure 6. Response to narrow rows on Prairie Coteau north of Watertown.



Q. Why might increased corn yields be expected from narrow rows in the higher elevations of northern South Dakota?

A. Short growing seasons with cool temperatures result in adapted corns being short in stature and restricted in leaf area. Consequently, with 40-inch rows a ground covering canopy is not as complete as with narrower rows so more of the sun's energy reaches the soil surface. Thus, wide rows permit a greater proportion of the total water loss to be by soil surface evaporation rather than from transpiration from the plant leaves. With narrow rows, more of the soil water lost to the atmosphere goes through the corn plant "factory."

Q. How large were the increases in yield from the narrow rows?

A. In 1970 the increases were about 4 bushels an acre and in 1969 they were approximately 7 bushels (Fig. 6). This amounts to about 9% and 20% more, respectively, of the yield from 40-inch rows. This is a larger percentage increase for narrow rows than was obtained in southeast South Dakota in a dry year where yields were comparable but bigger hybrids with a more complete leaf canopy were planted.□

Thinks like a man?

Experimental Automatic Irrigation System on Display at Redfield

How would you like to have an automatic irrigation system that—

- selects which of several fields need water,
- decides how much water is needed and for how long,
- turns the water on to rapidly fill the crop row,
- reduces the water flow when the row is filled,
- uses less water,
- minimizes runoff,
- minimize loss of rich topsoil,
- reduces drainage requirements,
- recycles to repeat the whole operation as often as needed,

—all without flicking a switch or making adjustments?

You'll be able to see an experimental prototype this summer near Redfield where South Dakota State University engineers will be checking performance of a "cutback" irrigation system. The preprogrammed system is to be installed, probably in July, in a row crop demonstration site at the Irrigation Research Substation east of Redfield, according to John L. Wiersma, director of the Water Resources Institute which coordinates the preliminary cutback system research by electrical and agricultural engineers.

Take Man's Place

The experimental system attempts to coordinate the electrical operation of a series of devices which would take the place of the thinking, experience and labor of a man trying to get the right amount of irrigation water at the right time on several different fields of growing crops.

The "cutback" part of the name clearly describes the reason for the design and development of the system—it "cuts back" the flow of water, says Richard E. Kraft, a graduate teaching assistant in electrical engineering who is doing research with the system while obtaining a masters degree at SDSU.

"Plant and soil scientists from the Agricultural Experiment Station help us determine the circumstances of when and how much water a particular crop or field needs—then we build into our system the program to provide this amount of irrigation," adds the young investigator from Pipestone, Minn. "As the amount of water is predetermined, there is little waste, erosion is minimized and a surface drainage system is not a crucial factor.

Kraft's part of the research involves the electronics phase of design and testing components for special valves which control the water flow rate into the field plus the overall control system that triggers the valves to provide irrigation water to selected fields.

Preprogrammed Signals

The system uses a length of irrigation pipe placed at the upper end of each field. Water flows from the pipe through bored outlets that coincide with crop row spacing. Irrigation water control at this field outlet is maintained by an electric motor-operated valve which receives electrical "signals" from a preprogrammed central control center.

The automatic sequencer is programmed so that water flows from the outlet pipe at the highest rate onto a designated field until the water reaches the lower end of the field, then it cuts-back to a lower flow rate by partially closing the control valve while another field is cut-in to the system at the initial high rate. When this second field goes into the lower flow rate and a third to the high, the flow is stopped at the first field. This sequence is continued for all fields, or stations, then it resets to the "rest" stage where all valves are off until the system is "told" to repeat the operation.

Until special soil moisture sensing devices are sufficiently develop-

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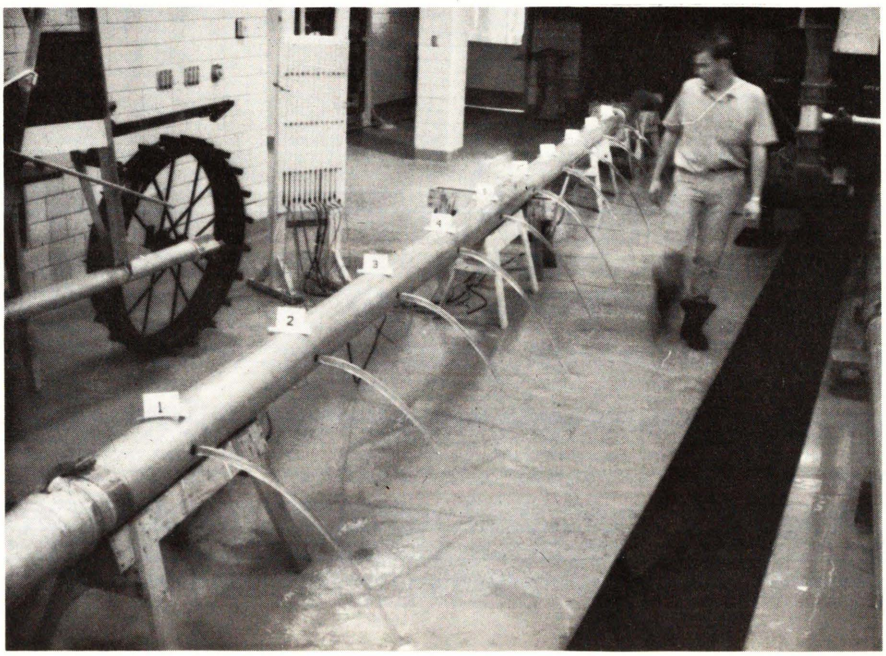
Controlled water streams flowing through 1-inch diameter non-regulating orifices. In use, this pipe would be at the upper end of the field with the streams of water flowing into crop rows.



ed to be integrated into the system, the preprogramming is based on calculations involving soil type and moisture holding capacity, climate, slope, crop being grown, plus other factors determined by agricultural engineers and agronomists, Kraft explains. These sensing devices are being studied in other research. A newly-funded WRI project will investigate possibilities of determining surface soil water content by use of reverberating soundwaves. When, and if, such soil moisture sensors become practical and available for use in the field, the crop could then "call" for irrigation when needed instead of preprogramming the water flow on a time basis as is done in the current system. Such a system would not be cheap although research design criteria assign major importance to economy in component selection.

Dr. John L. Wiersma (left), director of the Water Resources Institute, and Richard E. Kraft, electrical engineering graduate student, review design considerations for the electric motor-driven field outlet valve which is a major feature of the experimental cutback irrigation system.

Correct Water Flow Maintained

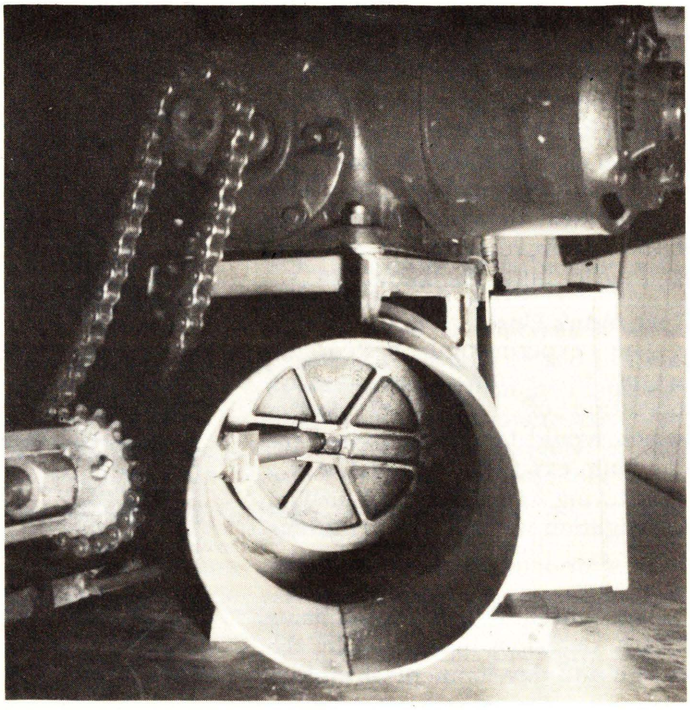
The water pressure downstream from the field valve in the outlet pipe is monitored by a pressure sensor which causes the valve to have the proper opening so as to maintain the correct irrigation water flow at the proper pre-determined rate.

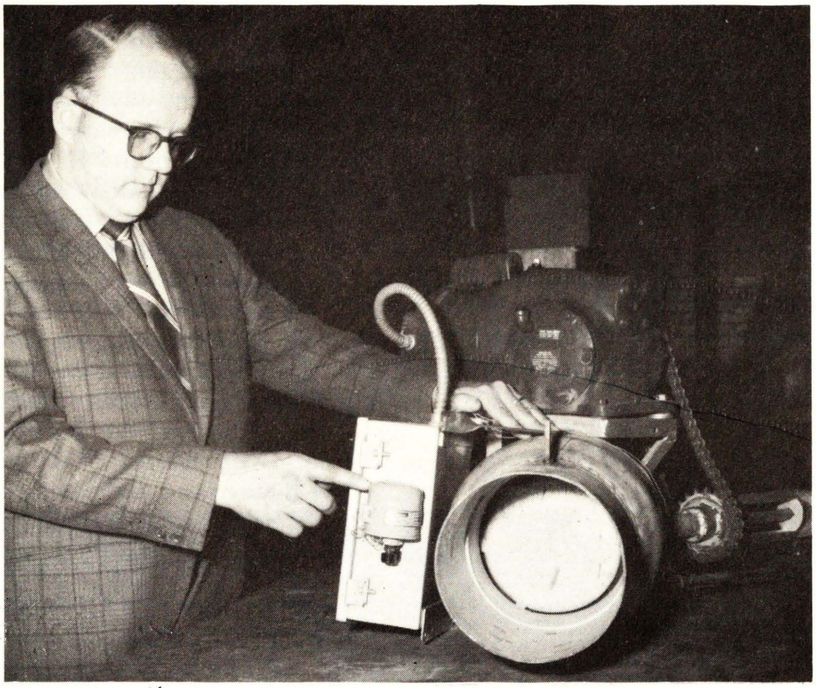
One objective is to regulate water flow through the entire system so a constant load is maintained; thereby upgrading efficiency of the water supply pump as well as reducing valve operation to a minimum.

When will row crop producers be able to obtain preprogrammed automation in their irrigation systems? Aelred J. Kurtenbach, associate professor of electrical engineering who is principal investigator and advisor for the project, says much of the preliminary work so far does establish the feasibility of such systems.

"We've made some improvements since last summer when the system was first used at Redfield," Dr. Kurtenbach adds. "We'll get additional information this summer on performance of the various components, both individually and collectively."□

Looking into the upstream side of the field outlet valve with operating components at left and above. A permanent split capacitor motor has been selected for use because of its characteristics of high starting torque and ease of being reversed.



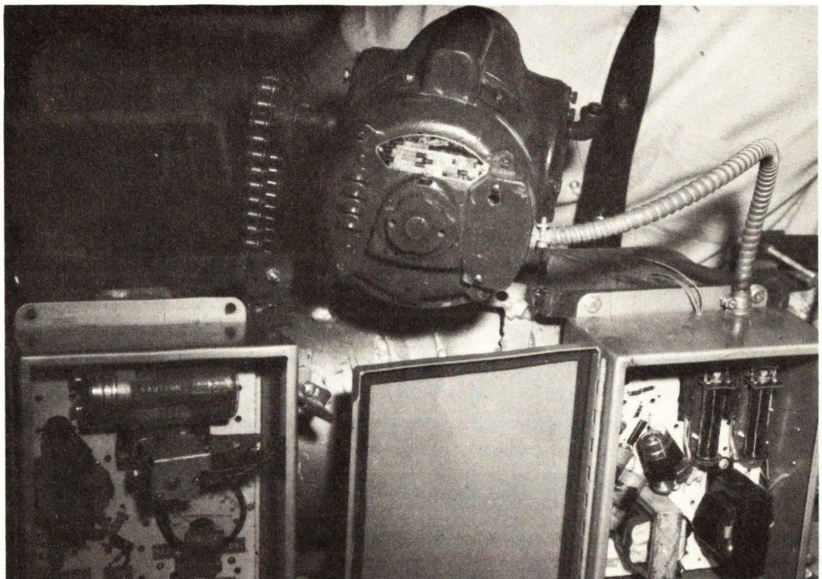


The field outlet valve from the downstream side. Dr. Duane E. Sander, associate professor of electrical engineering and co-investigator in the research, directs attention to the weather-proof housing which contains the sensing and control electronics. Any deviation in preset downstream water pressure is picked up by the sensor, amplified by sensing electronics, and the valve opening is altered to return water pressure to the proper setting.

Kraft demonstrates the system sequencer which switches previously-determined water pressure settings onto the field outlet valve for most efficient water usage. When the cutback system is in operation the sequencer is placed either at the head end of the field, at the water source or pumping station.

Dr. Aelred J. Kurtenbach, associate professor of electrical engineering and in charge of this research project, indicates limits switches incorporated into the system for over-ride protection.

A side view of the field outlet valve connected into the cutback system and ready for testing. The sensing and control electronics are on the right in the normal location. The system sequencer (left) has been placed in this position for demonstration only.



Plant monitors for . . .

south dakota's smog

PLANT scientists are going to try tobacco as a brand new "crop" in South Dakota this year. It will be planted in Rapid City, Sioux Falls, Pierre, Milbank, Martin, Highmore, Presho, Beresford, and Brookings.

From the outset, tobacco in South Dakota is not anticipated as a production agriculture crop but nevertheless it will be important. It is to be used to measure possible air pollution of the "big city smog-type" in South Dakota's pure air and sunny skies.

Last spring Wayne S. Gardner, a plant pathologist with the Agricultural Experiment Station, identified damage to experimental tobacco plants in Brookings as ozone injury, resulting from smog-type air pollution usually associated with large cities and industrial areas. Origin of this air pollution was not determined.

The associate professor in the Plant Science Department first noticed tiny white flecks on leaves of tobacco used as "indicator plants" in his laboratory research on virus diseases in South Dakota field crops. At first he thought the flecks might be spray damage. Later he noticed even heavier damage to leaves of tobacco plants growing outside in the SDSU campus pharmaceutical gardens.

Tobacco generally is one of the most sensitive plants to air pollution. It is commonly used in greenhouse research as an indicator of certain field crop virus diseases.

Ozone is claimed to be the most damaging pollutant to plants identified so far. Air pollution has cut some citrus and grape yields by as much as 50% near smog-laden Los Angeles and nationwide annual losses to crops have been estimated at anywhere between $100 million and $1 billion.

Studies of the effects of air pollution on plants is fairly new and research is aimed at producing plant varieties with resistance to air pollution. Among the most sensitive plants to air pollution are tobacco, soybeans, peanuts, alfalfa, cotton, tomatoes, squash, radishes, snapbeans, sweet corn, many of the leafy vegetables such as spinach, white ash, white pine, ponderosa pine, petunia, and small grains.

Automobiles Usually Blamed

"South Dakota has few of the potential sources normally associated with air pollution of this type," explains Dr. Gardner who formerly worked for private industry in tracing air pollution. He adds that automobiles are often the No. 1 source of the substances resulting from combustion which under certain atmospheric conditions react with oxygen in the presence of sunlight to form ozone. Transportation, industry, generation of electricity, space heating, refuse disposal—any burning operation—usually associated with cities are other sources.

"While our tourist traffic is high during the season, it is far less than freeway traffic in the East and West," he says. "We don't have large industrial centers and even if you consider Sioux Falls 50 miles away you must take into consideration an air dispersion factor."

Although the air pollution levels found in Brookings last summer were not high, the mere fact that it "can happen here" should be logged as another of those early warnings that our wide open spaces are not immune from pollution, Dr. Gardner comments. It takes only 8 parts per 100,000,000 of ozone in the air for up to 4 hours to cause damage to tobacco, one of the most sensitive plants. Dangerous levels near some large cities are up to four times this amount, he adds.

Grapes and alfalfa, two other fairly sensitive plants, apparently were not damaged last year. Damage to economically important plants from air pollution has become a major problem in some regions of the United States and resistance to these toxic factors has been incorporated into some crops by plant breeders.

Temperature Inversion

Dr. Gardner believes the latest ozone injury last year occurred about August 9-11 when there was light air movement in the Brookings area and ground-hugging smog continued throughout the day. William F. Lytle, in charge of weather research for the Agricultural Experiment Station, also noted stable atmospheric conditions several times last summer which could have been associated with temperature inversion situations similar to those which "trap" smog over large industrial and heavily populated areas.

In checking high altitude soundings made by the Weather Bureau at Huron, Lytle learned that on August 9 there was a temperature inversion over this area in which a mass of warmer air trapped a mass of cooler air below. Although ozone is also produced by thunderstorms and numerous such storms were reported in South Dakota on August 10, 1970, Lytle believes this source would not contribute a sufficient concentration of ozone for plant injury as found by Dr. Gardner.

Late last summer, Dr. Howard E. Heggestad, a recognized expert in air pollution damage to plants, during a visit with relatives in Brookings heard about the findings of Dr. Gardner. On checking the plants in the SDSU laboratory and the campus pharmaceutical gardens, Dr. Heggestad confirmed that the leaf injury was typical of that caused by atmospheric ozone, and similar to that observed by him for many years. He said that the nearest location of such injury on tobacco was in Wisconsin. He suggested that the ozone source might be in part tropospheric (from the upper air) as well as from activities of man and photochemical air pollution.

Tobacco Plants to be Used

The tobacco showing injury appeared to be *Nicotiana tabaccum* variety 'Havana 38', a cigar wrapping type often used by plant virologists as an indicator plant, and *Nicotiana rustica,* variety 'Braziliensis.' Dr. Heggestad suggested also the use of a sensitive variety of petunia, variety 'White Cascade' and that he was interested in learning of the results. He is presently in charge of the Plant Air Pollution laboratory, Plant Industry Station, USDA, Beltsville, Maryland. He has worked with Dr. J. T. Middleton, who is in charge of all air pollution investigations for the U. S. government and they were authors of the first publication linking the weather-fleck disease of tobacco to ozone injury.

In the absence of costly air sampling equipment, Dr. Gardner hopes the experimental tobacco plants growing as air pollution detectors will provide readings for several points this year. County Extension agents will assist him in keeping close tab on the plants, looking for possible ozone injury.

"Even if we don't detect ozone injury, our effort will be worthwhile," comments the SDSU plant pathologist. "One of the main reasons for making such a survey at this time is to get a 'yes' or 'no' reaction. If the reaction indicates there is such pollution (and possibly a general idea of how much), we'll have a benchmark to go by for future measurements. If the reaction indicates no pollution of this type and we find it does occur in the future, we might be better able to pinpoint about what is causing it."□

Ozone injury to tobacco plants detected last year in Brookings. The typical white "flecks" (lower left leaf of potted plant) were first noted in plant pathology laboratories at SDSU. Further investigation revealed ozone damage to tobacco plants in the campus pharmaceutical gardens (closeup). Photos were taken by Dr. Wayne S. Gardner, who first identified the damage.

Economic Aspects of Pollution

There's no getting around it that improvement of our environment (controlling pollution) is going to cost a lot of money and all of us are involved in the payment.

It is also true that pollution itself is very costly, and all of us are paying, with the bill likely to go much higher.

If such is the case, then let's look at it this way: if we can shift the cost of pollution over to the cost of improving our environment (and keeping the improvement intact) then much of the financing becomes a shifting of funds.

While it isn't exactly that simple, the idea does offer food for thought as suggested in this discussion by Dr. J. E. Wiebe, assistant professor of economics, South Dakota State University.

THE GROWING public concern about environmental quality has spurred research in many areas related to pollution. Actually, as a review of literature on environmental quality will reveal, a fair understanding of the physical aspects of pollution exists. What is not so obvious is an understanding of how we got to where we are in the pollution problem and where we go from here. Let's examine, from an economic point of view and philosophically, some causes of pollution and consider alternatives which might help solve the problem.

Causes of Problem

Environmental problems seldom stem from simple causes. Rather they usually rise out of the interplay of many contributing circumstances. Misdirected incentives in the economic system are an example. Our price system fails to reflect environmental damage the polluter may inflict on others. Such damages are referred to as external or social costs, and involve the ability of a producer to use water or air as a free resource for waste disposal, while others bear the cost of contaminated air or water (1). This cost may be paid in direct monetary terms as in the case of increased cleaning bills or in more subtle terms such as health and aesthetic considerations.

Values of the average American and the impact of population also have been cited as circumstances contributing to pollution. In the case of values it is maintained that too great an emphasis is placed on measurable rather than non-measurable priorities. Elements such as smog and loss of beaches in California are given as examples of the effect of population pressures on the environment (2).

Effects of Technology

Our choice of technology has been mentioned as one of the main causes of our environmental problem. Changes in technology have greatly increased production of material goods. But often the effects of technology have been at cross purposes with the natural environmental systems that support technology itself. Most activities depend on the proper functioning of the environment. Without photosynthesis in plants, for example, there would be insufficient oxygen for animal life or internal combustion engines. It is often argued that if pollution causes major conflicts between our system of production and the environmental system that supports it, then the productivity system should yield to environmental preservatives(3).

An example of a problem created by technological achievements in agriculture centers on replacing the natural supply of plant nutrients with inorganic fertilizers, especially nitrogen. Fertilizers may increase crop yield but at the same time alter the physical character of the soil, especially its porosity to oxygen. This can reduce the efficiency with which added fertilizer is taken up by the crop. As a result, un-used nitrogen may be leached and enter our water supply.

The insecticide problem is another example. Reports show that outbreaks of insect pests have been induced by use of modern insecticides that killed both natural predators and parasitic insects which ordinarily kept the spread of pests under control. This suggests that major problems in environmental pollution may arise, not because of inadequacies in our new technology, but because of the very success of these new technologies in accomplishing their designed aims. Modern fertilizers result in nitrate pollutants in our water supplies because they succeed in the aim of raising the nutrient level of the soil. Modern insecticides kill birds, fish and useful insects because they are successful in being absorbed by insects and killing them as intended(4).

Cost of Pollution

A question often raised is what is the cost of pollution? Before we answer this question we have to know whose cost we are talking about. The producer, for example, who may be the major pollutor, may not be adversely affected by his polluting activities. A livestock producer might dispose of manure in a manner not agreeable to others rather than by spreading it on the land. He may choose this course of action because to him commercial fertilizer is a cheaper source of plant nutrients(5).

On the other hand, for the rest of society there are additional costs involved. There are the social or external costs referred to earlier. This cost is not easily determined, however, because the economics of environment is such, that at least in the short run, the existing price structure and market institutions often tend to be ineffective in measuring such costs. Even identifying some of the less obvious costs is not always easy. If social costs are not included in production decisions, such as how much fertilizer to use, a misallocation of resources may result from the point of view of society(6).

If a misallocation of resources is not to take place, the problem then is to find a way in which social costs can be incorporated in the decision-making process. The framework in which such a decision should be made would involve comparing the total benefits of a production practice to society with the total costs of that practice to society. The point where benefits exceeded costs by the greatest amount would be the point of optimum use of a factor of production.

Another way of looking at this would be to consider the use of additional increments of a factor of production, such as fertilizers, and measure the changes in benefits and costs associated with added units of input. As long as added benefits exceed added costs, more fertilizer should be used. If added costs exceed added benefits, a reduction in fertilizers would be justified. When they are equal the right quantity of fertilizer would be used to maximize net benefits to society(7).

Perhaps the most difficult problem involved in maximizing net benefits to society is the measurement of social costs. The traditional application of economic theory on resource use and allocation has little relation to problems involving environmental quality. Much of the difficulty of measurement centers on the non-monetary values involved. Monetary values or gains may become an unmeasurable factor when environmental quality is involved. If total benefits and costs were balanced, there could still be an equity problem existing between individuals, unless the gainers who enjoyed net benefits actually compensated losers(8).

Pollution Control—At a Cost

It is readily agreed that pollution is a problem stemming from more than one cause. But less apparent than the fact of pollution is what can be done about it. The federal government has the necessary legislation to play a leading role in pollution abatement. This legistration is designed to encourage states to take a more aggressive stand on improving environmental quality. There seems to be little doubt that the law has a continuing and expanding role to play if pollution is to be controlled(9).

A concept sociologists refer to as a "cultural lag" indicates that man's attitude and social customs often do not keep pace with production practices. This is especially true in controlling pollution. A change in attitude on the part of society has been suggested as the single, most important change needed if we are to accomplish much in the abatement of pollution. While in the past we have been fairly successful in controlling our natural environment, wasteful productive practices become increasingly unadaptive as the saturation level of space and resource use is approached. Emphasis should be shifted to measures such as the recycling and reuse of resources, regulation of land use, complete waste disposal treatment and the peaceful coexistence of man and nature in general(10).

Assume, as appears to be the case, that society is becoming dedicated to the task of improvement of environmental quality. Who can be expected to bear the cost? It would appear that the costs will largely fall on consumers regardless of who undertakes such a corrective program. Government expenditure would ultimately be borne by the taxpayer; costs imposed on the private sector would also probably be passed on to the consumer. In some cases, environmental improvement measures might be paid for, over a period, by the reclamation and utilization of what are presently considered waste products. It appears, however, that there is no way for the consumer to avoid all pollution abatement costs and from society's standpoint it would appear to be cheaper to control pollution than to allow environmental deterioration to continue(11).

Summary

A problem of pollution exists. This problem, in many cases, was brought about by economic pressures in production practices and by a lack of understanding of the many ramifications of new technology. Environmental deterioration can be lessened but at a cost much of which will ultimately be borne by the consumer. Since pollution is already costing the consumer something in monetary and non-monetary ways, he may be willing to share a part of the cost of environmental improvement.□

(1) *Environmental Quality,* The First Annual Report of the Council on Environmental Quality, Transmitted to Congress, August, 1970, p. 12.

(2) *Ibid.,* pp. 13-14.

(3) See, *Ibid.,* pp. 14-15; Barry Commer, "Salvation: It's Possible," *The Progressive,* April, 1970, pp. 12-13.

(4) *Ibid.,* pp. 13-14.

(5) *Ibid.,* p. 14; John Gerstner, "The Great Manure Dilemma," *The Furrow,* September-October, 1970, pp. 2-3.

(6) Kenneth E. Boulding, "No Second Chance for Man," *The Progressive,* April, 1970, pp. 40-41; Alan Fox and David J. Allee, "Economic Evaluation of External Effects of Fertilizer Use," *Relationship of Agriculture to Soil and Water Pollution,* Cornell University Conference on Agricultural Waste Manage,-ment, January 19-21, 1970, pp. 188-189.

(7) *Ibid.,* p. 189.

(8) *Ibid,* p. 189-190; W. R. Boggress and R. J. Miller, "Improving Environmental Quality—A Major Goal in Agricultural Research," *Illinois Research,* Vol. 12, No. 4, Fall, 1970 (Urbana-Champaign: University of Illinois Agricultural Experiment Station), p. 3; Also see, Melvin Warren Reder, *Studies in the Theory of Welfare Economics* (New York: Columbia University Press, 1948), pp. 21-46, 188-189.

(9) William R. Wakler, "Legal Restraints on Agricultural Pollution," *Relationship of Agriculture to Soil and Water Pollution,* pp. 239-241.

(10) Eugene P. Odum, "The Attitude Revolution," *The Crisis of Survival,* by editors of The Progressive (Madison: Scott, Foresman and Company, 1970), pp. 12-15.

(11) Senator Gaylord A. Nelson, "Our Polluted Planet," *Ibid.,* pp. 192-193.

Japan's Market Important to U.S. Wheat Producers

By
William F. Payne, assistant professor,
Economics Department, Agricultural
Experiment Station.

BECAUSE domestic demand for agricultural products has not been increasing as fast as supply, the export market has become an important source of demand for U. S. farm products. Foreign purchases of agricultural commodities during fiscal year (FY) 1970 was $6,646 million. This amount was equivalent to 14% of the $47.2 billion in cash receipts from U. S. farm marketings in 1969. Agricultural and food exports also support jobs for an estimated 729,000 U. S. workers.

Agricultural exports from the West North Central region (South Dakota, North Dakota, Minnesota, Iowa, Nebraska, Kansas, Missouri) amounted to 28% of the nation's farm product exports during FY 1970. This made our region one of the top three exporting areas of the country, with farm exports reaching $1,863 million. Table 1 indicates that South Dakota received $87.4 million in foreign sales, which is approximately 9% of the State's cash farm income. (Cash farm income is the value of commodities sold off the farm.) Table 2 shows that wheat heads the list of South Dakota farm exports, with sales of $33 million. Approximately 69 cents out of every dollar received from wheat sales came from a foreign buyer in FY 1970.

Japan a Top Market

The top foreign markets for U. S. farm products during FY 1970 were Japan, West Germany, Canada, the United Kingdom, and the Netherlands. Japan has consistently been a major foreign market in recent years. U. S. farm exports to Japan reached $1,089 million in FY 1970. This was the first time that such exports to a single foreign country have surpassed the billion dollar level. With a rapidly expanding economy, Japan is expected to remain an important foreign market for U. S. agricultural products.

Table 1. Value of South Dakota agricultural exports, selected years 1965-1970.

Fiscal year	Value of agricultural exports	Exports as percent of cash farm income
	(Million Dollars)	(Percent)
1969-70	87.4	9.0
1967-68	95.1	10.0
1965-66	84.3	9.5

Table 2. Primary farm exports, South Dakota, FY 1970.

Commodity	Value (million dollars)	Exports as percent of cash farm receipts*
Wheat and flour	33.0	69.0
Govt. program	13.4	
Commercial	19.6	
Total feed grain†	18.0	22.0
Govt. program	1.1	
Commercial	16.9	
Soybeans	6.0	46.0
Govt. program	0	
Commercial	6.0	
Flaxseed	4.3	19.0
Govt. program	0	
Commercial	4.3	
Dairy products	2.7	4.0
Govt. program	2.2	
Commercial	.5	

Sources: (1) ERS, USDA "Foreign Agricultural Trade of the United States," October 1970, p. 29.
(2) ERS, USDA, FIS216 Supplement "Farm Income State Estimates 1949-1969," August 1970, p. 103.

*Fiscal year 1970 value of exports as percent of calendar year 1969 cash farm receipts.

†Includes corn, grain sorghum, barley and oats.

The Japanese market is especially important to wheat producers. For several years Japan has been the largest commercial outlet for U. S. wheat. During FY 1970, for example, Japan purchased 83.67 million bushels of wheat from the U. S. at a cost of $136 million. Presently South Dakota is not a major supplier of wheat to Japan.

Bread rolls and milk in school lunch program since World War II have helped change the Japanese diet. (Photo courtesy Foreign Agriculture magazine).

However, the Japanese market is important to South Dakota for two reasons. First, regardless of which state produces the actual commodities moving to Japan, all producers benefit from a market enlarged by foreign sales. Wheat shipped to foreign markets does not contribute to over-supply and low prices on the domestic market. Second, dietary changes to be discussed later could lead to increased sales of South Dakota wheat to Japan. Because we are in an era of increasing competition in foreign trade it is important to examine the programs of Japan in an effort to understand the factors which determine Japanese agricultural imports.

Japanese Producers Protected

Japanese wheat producers are protected from international competition by a very effective nontariff device—state trading. The government, acting through the Japanese Food Agency, determines the amount of wheat to be imported. Private importers then purchase the wheat on the world market and sell it to the government for re-sale to flour millers.

The Japanese food grain programs during the 1960's have had three main targets: (1) increasing farm income, (2) maintaining low foodstuff prices, and (3) preventing "excessive" government expenditures. To attain these objectives the government has employed several policy instruments.

The primary instrument consists of wheat price supports to producers. During Japanese fiscal year 1969 (JFY begins April 1 of year stated) price support activities permitted Japanese wheat producers to receive an average price of $4.03 per bushel. This was about 121% above the landed price of $1.83 per bushel for equivalent quality wheat purchased on the international market.

A second instrument of Japanese food grain policy is government purchase of domestic wheat at the support price and re-sale to processors at a lower price. Because of this instrument, farm support prices during JFY 1969 were 61% above the $2.44 per bushel government re-sale price of domestic wheat.

"Skimming"

The third policy instrument used in Japanese food grain programs is government purchase of imported wheat at world prices and re-sale to processors at *higher* prices. This process is referred to as "skimming." The difference between Food Agency re-sale price and acquisition price is equivalent to a tax which Japanese processors must pay when purchasing foreign wheat. This equivalent tax will vary, depending upon the particular type of wheat imported. But for imported wheat of equal quality to Japanese wheat, domestic processors paid an equivalent tax of 43% per bushel during JFY 1969. The process of selling imported wheat for a profit has the same effect upon government revenue as levying a tariff on imports. During JFY 1969 "skimming" revenue was about 30% above government purchase cost.

However, this "skimming" revenue is not sufficient to offset the sharply rising costs of the wheat program. The result is increasing pressure to alter Japanese wheat policies. Other fores for change include high processor equivalent tax rates and shifting dietary preferences within Japan. The interdependency of world trade patterns suggests that changing Japanese agricultural policies will have an impact upon U. S. agriculture. The implications of Japan's future policies for South Dakota should be viewed in this broad perspective. In particular, Japanese food policies should be viewed as a whole, with emphasis upon trends in dietary habits.

As incomes rise, Japanese consumers are buying more bread and less noodles and confectionaries. This increases the demand for hard wheats and decreases the demand for soft wheats. Bread is also increasing in popularity among young people, which further strengthens the demand for hard wheat. Thus South Dakota, with its large supplies of high quality bread wheats should watch this development closely, and stand ready to take advantage of this shifting demand as it develops.□

foil mulch on potatoes

By
Paul Prashar, associate professor, and
Wesley A. Urdahl, assistant, Horticulture-Forestry Department; and
Quentin S. Kingsley, assistant professor, Plant Science Department, Agricultural Experiment Station.

MULCHING plants to improve growing conditions is a practice recorded since early agriculture writings. Advantages include promotion of earliness, increased yields, and fewer defects in marketed products.

These improvements are accomplished by reducing evaporation, fertilizer loss, weed competition, and erosion. In addition, soil structure is improved, fruits are cleaner, soil temperatures or micro-climates are modified and the total feeding area of plants is increased by allowing roots to extend towards the soil surface. Unless advantage is taken of such factors, few if any, beneficial responses will occur and mulching will be of little value.

However, mulches do not always increase yields. The crop, time of year, soil type, rainfall, and air and soil temperature all influence plant response to mulching. Research by the Agricultural Experiment Station using special paper coated with aluminum foil as a mulch to conserve moisture in the important potato growing region of northeastern South Dakota indicates that the practice is not feasible for that area.

Long Time Research

Incorporating a paper mulch in vegetable growing has been under investigation elsewhere for nearly 50 years and has been successfully used for sugar cane and pineapple production in Hawaii. Experiments during that time showed that a paper mulch increased yield and hastened maturity of many vegetable crops. The paper mulch keeps the product off the ground, which is of considerable importance with some crops, such as tomatoes and melons. The paper mulch preserves moisture and eliminates weeds in the covered area and reduces the cost of cultivation. This is offset, however, by the cost of the paper mulch and labor of laying it.

Use of aluminum foil mulch, very encouraging in Florida potato production, has been shown in South Dakota research to have a disadvantage because of the lowering of soil temperatures. Potatoes are grown in Florida during winter and aluminum foil helps to keep the soil cool for the best production of the crop. In South Dakota, potatoes are planted in the spring when the soil is cool and the aluminum foil, by reflecting heat, prevents the soil from warming to optimum temperatures for best potato growth.

With moisture conservation as the main objective, a mulch of paper coated with aluminum foil was used in experiments to increase potato yields. The paper mulch was laid over the soil surface with a special machine. Advantages of aluminum foil paper as well as some of its limitations were considered before using this material as a mulch.

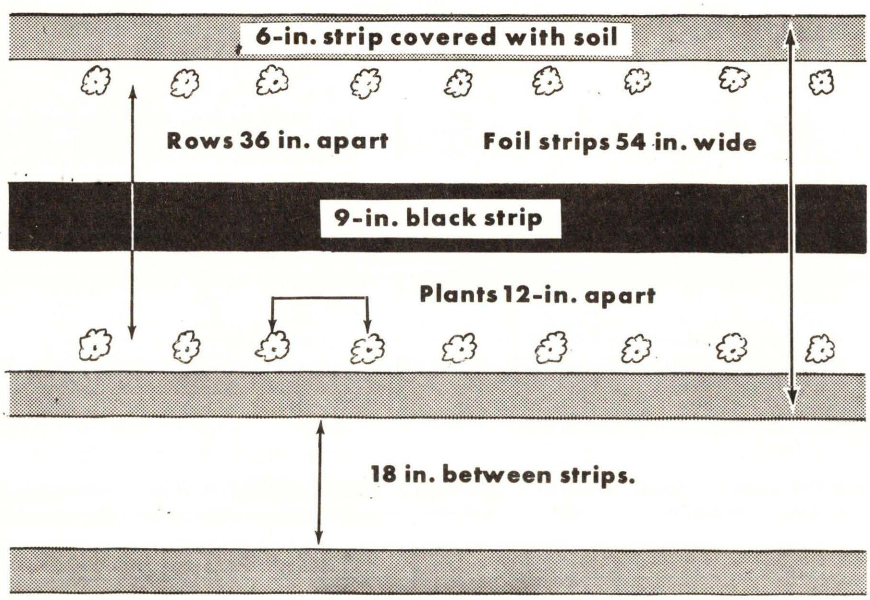
Table 1. Yield and size data of potato experiments near Garden City, S. D. 1970 season.

Replication	No. tubers Per Bu	Total yield Per 100 ft. row	% yield over 2 in.	% green over 2 in.	% rotted over 2 in.	% no. I over 2 in.
		(lbs.)				
Control 1	191	64.00	90.23	30.28	5.40	64.32
Control 2	189	66.50	88.34	18.50	3.60	77.90
Mulch 1	219	58.00	79.31	55.69	1.63	42.68
Mulch 2	203	61.00	85.24	43.26	4.80	51.94

Research Near Garden City

The experiment was conducted at the Northeast Research Farm near Garden City under dryland conditions similar to those in commercial plantings. Kennebec potatoes were planted on May 23, 1970 and harvested for yield on October 2. Rows were 36 inches apart and plants were spaced 12 inches apart within the row. The paper mulch was 54 inches wide, with a 9 inch black strip in the center. The purpose of the black strip was to absorb more heat and raise the soil temperature for favorable growth of potatoes. Six inches of the edge of each side of mulch was covered with soil. Potato seed pieces were planted by hand through the paper mulch. Weeds in the mulch plots were controlled by chemicals and in the check plots by cultivation. Rainfall amounted to 4.7 inches in June, 1.52 in July, 0.22 in August, and 1.66 in September.

Experimental Use of Aluminum Foil Mulch



Results

There was no significant difference between control and mulch plots for total yield, number of tubers per bushel, size of tubers, and pecentage of rotted potatoes. In the average of the control plots there were 24.39% green potatoes as compared to 49.48% in the mulch plots. No. 1 potatoes yielded 71.11% in control plots as compared to 47.31% under mulch. These differences were highly significant for green potatoes and No. 1 potatoes under control and mulch conditions.

Although the potato hills were planted through a small hole in the mulch, as the season progressed and plants grew larger the paper hole also increased in size, and the sunlight through these holes caused the potatoes to turn green.

Green potatoes have a bitter taste and may be poisonous because of the alkaloid, solanine, which develops in the potato along with the chlorophyll. Since solanine is a poisonous alkaloid, its presence in increased amounts in the green potato tubers is considered to be a health hazard. Potatoes containing more than 0.1% solanine are considered to be unfit for human consumption. Green potatoes are not acceptable for processing or table use. The green potatoes should be graded out before marketing the crop. Grading decreases yields, increases the expense, and results in a lowered income. There is no practical way that these potatoes could be covered to avoid sunlight. Potatoes commonly set tubers near the soil surface. The Kennebec variety is particularly notorious in this regard. The percentage of green tubers in control plots was very high in this experiment, but this could be reduced to 5% or less with proper ridging.

Conclusions

Under mulch, soil moisture was undoubtedly higher but it did not increase the yield of the crop. This was due to low soil temperature in the early part of the growing season. The aluminum foil reflected the sunlight and prevented the soil from reaching optimum temperature for best potato growth. As in other experiments, soil temperature was lowered 6°F. or more when an aluminum mulch was used. Plant yield is reduced if subjected to temperatures below the optimum for growth. Low temperature decreases both rate of photosynthesis and respiration, but photosynthesis rate decreases to a greater extent than that of respiration. When the temperature is below the optimum range for any given plant, rate of protein formation is low and in turn cell division is slowed. As a result, growth rate is reduced and the yield is accordingly low. This is why aluminum mulch did not increase the potato yield in this experiment.

Other operational difficulties in using aluminum mulch should not be overlooked, for instance:

- Cost of aluminum paper is about $200 per acre. To justify mulching in commercial production an economic return must be realized either from increased yield or from saving in operating costs. Aluminum mulch does not appear to be justified in this area for general potato production.
- A special machine is needed to lay the mulch.
- It is difficult to control weeds between the mulch strips.
- Currently no method is known by which numbers of green potatoes can be decreased under paper mulch.
- Difficulties were encountered in digging potatoes in mulched rows because the paper mulch was too wide when two rows were dug together. This problem can be solved by cutting the mulch paper down the center.
- The mulch paper did not deteriorate as expected. It could present some problems to the grower, such as litter in the field when plowing and catching in fences.□

Semi-Dwarf Spring Wheat in South Dakota

By
Vanrat Sompaew, graduate student; and
D. G. Wells, professor in Plant Science
Department, Agricultural Experiment Station

SHORT wheat is here.

Used by the Japanese for about 100 years, semi-dwarfs have recently found a place in most wheat growing regions in the world.

Spring and winter semi-dwarfs have been tested in South Dakota for 9 years, with more intensive work on spring types the past 4 years. Results show that spring wheat often yields more grain when fertilizer is added, especially if the weather is favorable. But what about the semi-dwarf wheats bred in the international program in Mexico or elsewhere and being sold here? How should they be managed?

Methods

The first study of the response of semi-dwarfs to changes in moisture and fertilizer supplies in South Dakota was completed in 1969. The results for 1 year are reported here. The bread wheats were the tall check, Chris (an old standby in this area) and two semi-dwarfs, Penjamo 62, and SDI6623, (both from Mexico). SDI6623 has the pedigree Sonora 64//Selkirk/Andes$_3$. The durum wheats were the tall check, Leeds (another well-known wheat) and the two semi-dwarfs, SDI669 and SDI6617 (developed in Mexico). SDI669 has the pedigree Pitic 62/St 464//Tehuacan$_2$/3/Lakota. SDI6617 has the pedigree Yaktana 54/N104/ /Langdon 357/3/Tehuacan$_2$. Choice of these six varieties was based on performance tests in 1967 at Brookings.

A soil test on the dryland experimental plots at Brookings indicated a poor supply of nitrogen and adequate phosphorus but only at lower nitrogen levels. Potash was adequate. Thirty-nine pounds of phosphorus as P_2O_5 were broadcast. Nitrogen as ammonium nitrate was broadcast by hand on the nursery at rates of none (check), 30 pounds, 60 pounds, 90 pounds, and 120 pounds per acre. The fertilizer was then plowed under and the plots seeded at a rate of 48 pounds an acre on April 4 with a press drill in rows 12 inches apart. A heavy rain April 8 was the only significant moisture for the next 60-day period.

A second test at Redfield under irrigation was on soil with a fair supply of nitrogen, adequate phosphorus at low nitrogen levels, and very high potash. Fertilizer was applied and land prepared the same as at Brookings except that a higher rate of phosphorus (107 pounds per acre) was used. The plots could not be seeded until May 8 because of wet soil. One irrigation on July 12 was needed. Foliage diseases and scab were controlled when necessary with chemicals.

The experiments measured yields of grain and straw, stands, number of heads with seed in them and seeds per head, weight of 200 seed (instead of test weight) plant height, lodging, and protein.

Results—Dryland

At Brookings heavy frosts April 24, May 3 and May 4 reduced stands. Plant counts made both before and after the frosts showed these percentages of losses:

Chris	6%
Penjamo 62	5%
SDI6623	4%
Leeds	4%
SDI669	25%
SDI6617	23%

Note that 2 of the 4 Mexican semi-dwarfs were more sensitive to frost than Chris and Leeds, varieties bred in the Midwest.

Bread Wheats (Table 1)

On dryland, with no added nitrogen, Chris and the two semi-dwarfs yielded about the same, 31-33 bushels an acre. Yields were slightly depressed by added nitrogen although not enough for statistical significance. The number of heads with seed tended to be lower where nitrogen was added, apparently accounting for the tendency for lower grain yields with added nitrogen under the droughty conditions.

Penjamo 62 had lowest stands and SDI6623 the highest. Plants compensate for low stands by tillering, as did Chris in this case, where it had fewer plants but more heads with seeds than did SDI6623.

The two semi-dwarfs usually produced significantly more seeds per head than Chris but this effect on comparative yield was modified by the ability of Chris to produce more heads.

Seed size, measured by weight of 200 seeds, was greater at all levels of nitrogen for Penjamo 62 than for Chris. This helped Penjamo overcome in yield its disadvantage in stand and number of heads bearing seeds.

Plant height was little affected by nitrogen rates. Chris was 8-10 inches taller than SDI6623 and 6-7 inches taller than Penjamo. Chris produced nearly a half ton an acre more straw than either semi-dwarf. Straw yields tended to be lower with added nitrogen. Only a trace of lodging occurred.

These two semi-dwarfs are known to be deficient in baking quality. They were ½%-2% lower in protein than Chris. Protein tended to rise with added nitrogen but not significantly.

Table 1. Dryland test at Brookings, 1968. Bread wheats.

	Rates of nitrogen					
	Check	30 lbs. N	60 lbs. N	90 lbs. N	120 lbs. N	Average
			BUSHELS			
Yield, grain						
Chris	33	30	28	28	28	30
Penjamo 62	31	29	29	29	28	29
SDI6623	31	28	30	28	26	28
			TONS			
Yield, straw—						
Chris	1.9	1.7	1.7	1.8	1.7	1.7
Penjamo 62	1.4	1.3	1.4	1.3	1.2	1.3
SDI6623	1.4	1.4	1.5	1.3	1.3	1.4
			NUMBER			
Plants (in 2' of row)—						
Chris	26	25	24	23	28	25
Penjamo 62	22	24	25	22	19	22
SDI6623	30	31	24	26	32	29
			NUMBER			
Heads with seeds (in 2' of row)—						
Chris	62	57	59	59	57	59
Penjamo 62	52	50	48	48	44	48
SDI6623	57	56	58	52	51	55
			NUMBER			
Seeds per head—						
Chris	25	26	25	26	26	26
Penjamo 62	26	26	27	28	29	27
SDI6623	29	28	30	28	26	28
			GRAMS			
200 seed weight—						
Chris	5.4	5.0	4.7	4.6	4.6	4.9
Penjamo 62	5.7	5.7	5.5	5.4	5.2	5.5
SDI6623	4.6	4.4	4.3	4.7	4.9	4.6
			INCHES			
Plant height—						
Chris	31	31	30	30	30	30
Penjamo 62	25	24	23	23	24	24
SDI6623	21	22	22	22	22	22
			PERCENT			
Lodging—						
Chris	5	3	3	3	3	3
Penjamo 62	3	2	2	2	2	2
SDI6623	2	1	1	1	0	1
			PERCENT			
Protein—						
Chris	15.1	15.7	16.1	16.0	15.9	15.7
Penjamo 62	13.4	13.5	14.0	13.8	13.8	13.7
SDI6623	14.5	14.6	14.7	14.6	14.8	14.6

Durum Wheats (Table 2)

Durum wheats at Brookings showed no significant differences in yield of grain among varieties or rates of nitrogen. However, a tendency was apparent for grain yields to rise for the two semi-dwarfs at one or both of the highest levels of nitrogen. They were bred, of course, for a high yield response at high soil fertility. More heads with seeds in them for SDI6617 tends to account for the higher yield at the upper levels of nitrogen.

Leeds had the best stands because of resistance to frost and also because of higher germination.

The two durum semi-dwarfs tended to produce more seeds per head and SDI669 to have larger seed. But these differences were not significant.

Leeds was 6-9 inches taller than the semi-dwarfs and produced more straw in some, but not all, treatments.

Differences in levels of protein were not significant between durum varieties and were not significantly raised by added nitrogen but tended to be higher, especially for Leeds.

Table 2. Dryland test at Brookings, 1968. Durum wheats.

	Rates of nitrogen					
	Check	30 lbs. N	60 lbs. N	90 lbs. N	120 lbs. N	Average
				BUSHELS		
Yield, grain—						
Leeds	31	30	31	33	29	31
SDI669	31	29	32	30	34	31
SDI6617	29	31	31	35	35	32
				TONS		
Yield, straw—						
Leeds	1.7	1.7	1.8	1.9	1.6	1.7
SDI669	1.7	1.5	1.7	1.6	1.7	1.6
SDI6617	1.4	1.5	1.5	1.6	1.6	1.5
				NUMBER		
Plants (in 2' of row)—						
Leeds	23	23	24	29	24	25
SDI669	19	15	22	14	19	18
SDI6617	19	17	21	20	22	20
				NUMBER		
Heads with seeds (in 2' of row)—						
Leeds	45	45	46	47	41	45
SDI669	44	39	48	37	45	43
SDI6617	42	41	44	48	47	44
				NUMBER		
Seeds per head—						
Leeds	25	25	26	26	27	26
SDI669	26	28	26	30	28	28
SDI6617	27	29	28	28	28	28
				GRAMS		
200 seed weight—						
Leeds	6.7	6.6	6.5	6.7	6.6	6.6
SDI669	6.9	6.8	6.5	6.8	6.8	6.7
SDI6617	6.4	6.4	6.1	6.4	6.4	6.3
				INCHES		
Plant height—						
Leeds	30	30	29	29	29	29
SDI669	22	23	22	23	22	22
SDI6617	21	22	21	22	22	22
				PERCENT		
Lodging—						
Leeds	1	1	1	2	2	1
SDI669	1	0	1	0	1	1
SDI6617	1	1	1	2	1	1
				PERCENT		
Protein—						
Leeds	14.8	16.1	16.4	16.5	16.5	16.0
SDI669	15.0	15.1	15.4	15.1	15.1	15.1
SDI6617	14.7	14.9	15.2	14.9	15.3	15.0

Results—Irrigation

Bread Wheats (Table 3)

Under irrigation at Redfield yield went up 31% across all six varieties at the 60 pound rate of nitrogen compared with the checks. Both semi-dwarfs were far ahead of Chris at the nitrogen check level but all three entries yielded in a range of 57 to 61 bushels at 30 pounds N. Yields generally rose through the 120 pound N rate suggesting that a further rise might have occurred if a 150 pound N rate had also been used. Chris was 7 bushels below SDI6623 and 14 bushels below Penjamo 62 at the 120 pound rate of N, and 6 bushels and 15 bushels below them at the 60 pound N rate. Results emphasize the value of fertilizing and using higher yielding varieties when moisture is not short.

Stands averaged 25 to 28 plants in 2 feet of row for varieties across all rates of N and varied considerably between treatments.

Except at the check level, Chris had more heads with seeds than Penjamo 62, but yielded less. Penjamo 62 had enough more and larger seeds per head to more than compensate for its lower head-producing ability. SDI6623 was similar to Chris in number of heads with seed and seeds per head but had larger seed than Chris by 14%, enough of an advantage to average 11% higher grain yields across all N rates.

Chris was 9-14 inches taller than the semi-dwarfs and averaged about half a ton more straw an acre. Only lodging of importance was 14% in Chris at the 120 pound rate of N.

Chris was 1%-2% higher than the semi-dwarfs in protein across all N rates. Protein rose steadily for all varieties as rates of N went up. Chris, however, went up 2.2% in protein between the check and 120 pound rate while the semi-dwarfs increased only 1.1% and 1.2%. Thus, bread wheats responded differently to added nitrogen with respect to percent protein.

Durum Wheats (Table 4)

Durums did not differ significantly in yield or in effects of N rates. Nitrogen rates made a significant difference in per-acre grain yield, however. Leeds reached its top yield of 69 bushels at 60 pounds of N while the two semi-dwarfs increased in yield through the 120 pound rate of N, suggesting that 150 pounds of N might have shown a still higher yield. SDI669 increased 18 bushels (36%) and SDI6617 increased 43 bushels (113%) from the check to the 120 pound rate of N. Leeds went up 42% from the check to the 120 pound rate of N.

Increases in all durum yields from added nitrogen were due mainly to an increase in heads that produced seeds. Seeds per head increased with added N only for SDI6617. Added nitrogen tended to reduce seed size for all the durums. However, Leeds and SDI669 seeds were significantly larger than for SDI6617.

Stands generally favored Leeds but differences were not statistically significant.

Leeds produced about half a ton more straw an acre than the semi-dwarfs at all levels of N which was significant. Straw yields went up significantly with added N.

Leeds was 13-15 inches taller than the two semi-dwarfs across all rates of N. Adding 120 pounds of N increased height over the check by 6 inches for Leeds, 4 inches for SDI669, and 5 inches for SDI6617.

Only lodging of significance was 19% for Leeds at 120 pounds N.

Protein levels were similar for varieties but rose significantly (by a maximum of 1.6%) with added nitrogen.

Conclusions

Under drought conditions at Brookings and a 29- to 33-bushel yield level, added nitrogen tended to depress yields of grain and to increase percentage of protein, but not significantly in either case. Tall and semi-dwarf varieties yielded about alike. Chris was 1%-2% higher in protein than the two semi-dwarfs. Chris and Leeds were 6-10 inches taller than the semi-dwarfs which were only 21-22 inches high.

Except for seeds per head for the durums, the three components of seed yield studied varied significantly between varieties on dryland. We don't known if a combination in one variety of the large seed size of Penjamo 62 and the greater number of heads of Chris would produce more grain than realized in this test.

Under irrigation, grain yields generally went up through the highest rate of nitrogen suggesting that a rate of 150 pounds might have produced even more grain. Durum entries, however, were not statistically different in yield in this test under irrigation. The 81-bushel yield of SDI6617 at 120 pounds of nitrogen was enough greater than all other durum yields to suggest a real difference that could not be statistically verified in this experiment.

Penjamo 62, a poor quality wheat, was the highest bread wheat yielder, exceeding Chris at 60 pounds of N by 27% and at 120 pounds of N by 23%. Penjamo yielded higher because of more and larger seed per head than Chris in spite of having fewer heads.

The semi-dwarfs when irrigated were up to 12 inches taller than on dryland. Chris and Leeds were up to 14 inches taller than on dryland but only lodged 14%-19% at the 120 pound rate of N.

Added nitrogen increased protein a maximum of 2.2% in Chris over the check but only 1.1% and 1.2% for the two semi-dwarfs.

Not all varieties of bread and durum wheat can be expected to respond as did those tested in this experiment. Undoubtedly someday there will be semi-dwarfs with as high or higher protein than Chris and the ability to respond to nitrogen fertilization as well or better than Chris. Plant height and such traits as protein level, seeds per head, heads per plant, seed size, reaction to diseases, and so on are enough independent of one another in inheritance so that any desired combination if traits can probably be made by the plant breeder.□

Table 3. Irrigated test at Redfield, 1968. Bread wheats.

	Rates of nitrogen					
	Check	30 lbs. N	60 lbs. N	90 lbs. N	120 lbs. N	Average
			BUSHELS			
Yield, grain—						
Chris	35	57	56	54	62	53
Penjamo 62	60	60	71	76	76	68
SDI6623	49	61	63	57	69	60
			TONS			
Yield, straw—						
Chris	1.8	2.8	3.1	3.4	3.7	3.0
Penjamo 62	2.1	2.3	2.6	3.0	2.9	2.6
SDI6623	1.8	2.4	2.6	2.4	3.1	2.5
			NUMBER			
Plants (in 2' of row)—						
Chris	21	31	26	28	25	26
Penjamo 62	27	25	22	22	28	25
SDI6623	31	26	30	28	27	28
			NUMBER			
Heads with seeds (in 2' of row)—						
Chris	47	80	73	79	79	72
Penjamo 62	56	57	63	70	68	63
SDI6623	63	72	77	71	83	73
			NUMBER			
Seeds per head—						
Chris	29	29	29	27	32	29
Penjamo 62	32	33	35	36	36	34
SDI6623	27	29	28	28	29	28
			GRAMS			
200 seed weight—						
Chris	6.3	6.3	6.5	6.4	6.2	6.3
Penjamo 62	8.1	7.9	8.0	7.7	7.7	7.9
SDI6623	7.2	7.2	7.4	7.1	7.2	7.2
			INCHES			
Plant height—						
Chris	40	42	43	45	44	42
Penjamo 62	30	33	33	34	33	33
SDI6623	26	29	30	31	31	30
			PERCENT			
Lodging—						
Chris	0	0	5	2	14	4
Penjamo 62	0	0	0	0	0	0
SDI6623	0	0	0	0	0	0
			PERCENT			
Protein—						
Chris	11.7	12.2	12.7	12.9	13.9	12.7
Penjamo 62	10.4	10.0	10.9	11.0	11.5	10.8
SDI6623	11.1	10.7	11.9	11.5	12.3	11.5

new grain sorghum hybrid

A new higher-yielding grain sorghum hybrid was released to commercial seed companies for planting in 1971 by the South Dakota Agricultural Experiment Station.

The new release, called RS 506, showed average yields nearly 10 bushels higher than two other comparative sorghums during 5 years of testing at major South Dakota locations, according to Allyn O. Lunden, of the Plant Science Department at South Dakota State University where the hybrid was developed. Average yield for the 17 tests was 87.3 bushels an acre and on irrigation at Redfield it averaged 141 bushels an acre during 3 years of testing.

Restorer Parent Also Released

In addition to the open-pedigree grain sorghum, its pollinator line or restorer parent, designated R-SD-104, was released. Seed of both RS 506 and R-SD104 became available to seed companies through a new release procedure by the Foundation Seed Stock Division at SDSU. The designation "RS 506" is carried on commercially-sold seed containers, says Lunden. He adds that germ plasm samples and 1-pound hybrid seed lots are available to sorghum breeders, research workers or others on request to the Foundation Seed Stock Division.

RS 506 is recommended as a full season hybrid in central South Dakota, as a midseason hybrid in south-central areas, and as a full season hybrid in northern areas of the state, says Lunden. It is about 3 days later than SD 451, is similar in maturity to SD 503, and is about 6 days earlier than RS 610.

Characteristics

Seeds are Martin brown and moderately large with mature seed test weight similar to RS 610. The new hybrid appears somewhat resistant to some types of bird damage, downy mildew, sorghum midge and some races of head smut but is susceptible to Race 3 of smut. It also appears susceptible to anthracnose and charcoal rot and is less resistant to lodging than RS 610 or ND 505. Because of the lodging disadvantage, Lunden strongly encourages potential users to consider timely harvest after frost before onset of lodging, swathing before lodging, or otherwise the use of combine attachments to pick up lodged stalks and heads.

About 400 bushels of Nebraska Interagency Certified RS 506 were produced last year by contract and about 2,000 pounds of R-SD104 were produced in South Dakota. Lunden adds that midwinter purity test evaluation in Mexico revealed superior genetic uniformity of this lot of hybrid seed and genetic stability of both the hybrid and the restorer line appears to be excellent. Hybrid seed will be available to farmers only through the various commercial seed companies.□

Table 4. Irrigated test at Redfield, 1968. Durum wheats.

	Rates of nitrogen					
	Check	30 lbs. N	60 lbs. N	90 lbs. N	120 lbs. N	Average
			BUSHELS			
Yield, grain—						
Leeds	45	46	69	68	64	58
SDI669	50	52	59	56	68	57
SDI6617	38	51	64	65	81	60
			TONS			
Yield, straw—						
Leeds	2.1	2.4	3.5	3.6	3.6	3.1
SDI669	2.0	2.1	2.7	2.4	3.1	2.4
SDI6617	1.6	2.2	3.0	2.8	3.5	2.6
			NUMBER			
Plants (in 2' of row)—						
Leeds	25	23	23	25	22	24
SDI669	21	19	18	21	19	20
SDI6617	21	24	24	26	21	23
			NUMBER			
Heads with seeds (in 2' of row)—						
Leeds	42	43	62	64	59	54
SDI669	40	45	49	49	56	48
SDI6617	35	49	63	64	68	56
			NUMBER			
Seeds per head—						
Leeds	31	31	33	32	32	32
SDI669	34	33	36	35	35	35
SDI6617	33	32	32	34	40	34
			GRAMS			
200 seed weight—						
Leeds	8.6	8.5	8.4	8.3	8.3	8.4
SDI669	8.8	8.8	8.2	8.3	8.5	8.6
SDI6617	8.0	8.0	7.7	7.5	7.4	7.7
			INCHES			
Plant height—						
Leeds	38	41	44	44	44	42
SDI669	27	28	30	30	31	29
SDI6617	25	26	27	28	30	27
			PERCENT			
Lodging—						
Leeds	0	0	4	7	19	6
SDI669	0	0	0	0	0	0
SDI6617	0	0	0	0	0	0
			PERCENT			
Protein—						
Leeds	11.4	11.0	11.9	11.8	12.7	11.8
SDI669	11.2	11.2	12.1	12.2	12.8	11.9
SDI6617	11.5	11.0	12.0	12.3	12.8	11.9

New method developed. . .

scheduling irrigations

A NEW, simple method of irrigation scheduling that provides the right amount of water at the right time is now available to eastern South Dakota corn and alfalfa growers.

The method, much like a system of "bookkeeping," gives the irrigator a daily running balance of how much moisture his soil contains, according to Delvin D. Brosz, agricultural engineer at South Dakota State University who developed the system for the Water Resourecs Institute and the Agricultural Experiment Station. Brosz adds that rainfall, irrigation applications, and moisture use by crops are taken into account in using the system.

"Water management is very important for getting the most out of an irrigation system in terms of crop production, conservation of moisture, and most efficient use of equipment," says the agricultural engineer. "Random application of water does little toward getting the best crop yields."

Detailed Instructions Available

Detailed instructions for using the new moisture accounting system are available through the Water Quality Laboratory in the Agricultural Engineering Department at SDSU or from County Extension agents. Instructions include steps to take in obtaining soil sample tests as well as for using daily moisture record sheets and daily estimated crop moisture use value sheets. The "bookkeeping" procedure takes about a minute daily to subtract crop moisture use or to add amount of rainfall or irrigation.

At least one initial soil test is needed right after corn is planted or in late April for a growing alfalfa crop. The soil test, for which a regular charge is made, the soil type, and the geographic location are used by Water Quality Lab technicians to determine amount of water the farmer needs to apply for each irrigation, the maximum amount of moisture that the soil can hold, and the minimum daily balance that indicates when irrigation is needed.

For Individual Enterprises

Brosz points out that costs of computer scheduling as used on large projects probably would be too great on a per-acre basis for eastern South Dakota where individual irrigation enterprises grow non-specialty crops. Although research has not yet determined crop moisture use figures area-wide for western South Dakota, Brosz says he can provide the data on an individual basis for using the method in that area.

The method gives the irrigator an illustrated running account (see form reproduced with this article) of soil moisture conditions which allows him to plan his water applications several days in advance. Irrigation water is applied on the basis of need — when and how much. This conserves water, time and other irrigation costs. The method is seen as a tool to augment the experience and judgment of the irrigator.

Equipment Needed

The irrigator needs a soil probe to obtain soil samples down into the root zone, a rain gage, and a device for accurate measurement of irrigation water. Although a water meter of the type which can be installed in an irrigation pipeline may cost from $150 to $300, Brosz says it should be a good investment for attaining maximum efficiency in an irrigation system that costs several thousand dollars. Farmers not investing in a water meter may obtain technical help for estimating amount of water applied.

Research this season will include potatoes and grain sorghum as two additional crops for which the moisture accounting system might be used.

The engineer has a final suggestion: the irrigator's wife can become a part of the irrigation enterprise by keeping track of the daily moisture additions or subtractions.□

This is the Field Moisture Record Sheet that the irrigator gets from the Water Quality Laboratory. Notations explain how it is used.

What the irrigator is trying to do is to keep the "balance" below the maximum amount of moisture his soil will hold and above the minimum soil moisture level when the crop should be irrigated to prevent yield losses. This is done in columns on the form by either adding inches of rainfall and irrigation water applied or by subtracting inches of daily crop moisture use. When the daily soil water balance approaches the minimum or danger zone, the field needs irrigating.

Calculated daily crop moisture use values, which are part of the "moisture accounting" package, are based on climatic conditions averaged from weather data covering at least 50 years in three zones of eastern South Dakota. Two sets of moisture use values are used for alfalfa, one providing adjusted data for a 3-week period after cutting.

Field Moisture Record Sheet

These figures, furnished by the laboratory, are based on soil type and on rooting depth of the particular crop.

IRRIGATOR ______________________ No. __________ AREA __________ MONTH __________ 19____

CROP ______________________ PLANTING DATE ______________________

MAXIMUM MOISTURE AVAILABLE FOR PLANT USE __________ IN.
(Daily balance may not exceed this value)

IRRIGATE WHEN DAILY BALANCE IS __________ IN.

Date	Rainfall (in)	Net Irrigation (in)	Daily Moisture Use (in)	Daily Balance (in)	Remarks
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					

A figure in this column, provided by the laboratory from the initial soil moisture test, is the "starting point." The figure is placed according to the date the soil sample was taken.

A — The irrigator computes this column based on adding for rainfall or irrigation and subtracting moisture use by the crop.

B — Figures in this column are provided by the laboratory in hundredths of an inch.

C — This column is used by the irrigator to record irrigations.

D — This column is used by the irrigator to record rainfall.

How Much Do You Pay for Soil Erosion?

SOIL erosion, rated South Dakota's top source of agricultural pollution, is too-often glaringly evident.

Not so apparent, however, are insidious side effects that have actually robbed South Dakotans of millions of dollars. Prevention of soil erosion is often cited—rightly or wrongly—as a seemingly costly method of controlling pollution which evidentally isn't doing much good. But unfettered soil erosion itself may cost as much as, possibly more, than control methods or practices.

Soil conservation and erosion control have been incorporated in farming practices for years but, unfortunately, only on a comparatively small, usually voluntary basis. Soil conservation has helped. . . "we'd be farther down the road toward much worse pollution without it," say conservationists. Considerable knowledge for controlling erosion is already available which put into use, could reduce the problem by at least an estimated 75%.

Erosion Against the Law?

If this knowledge is not put into use, South Dakotans may find they are facing a situation stemming from a school of thought which says, as summed up by a Cornell University professor: "The right of an individual to his land is secondary to that of society's need for productive soil. Soil, like air or water, is a national resource, and no individual should be able to alter its quality without being subject to legal action." Erosion that causes pollution is against the law in Pennsylvania, according to a 1970 amendment which gives the State Sanitary Water Board the authority to eliminate sources of pollution, including sediment, or to develop practices that will reduce pollution to an acceptable standard.

South Dakota Agricultural Experiment Station agronomists and soil scientists claim that when South Dakotans become more aware of the costs of soil erosion, in terms of both direct out-of-pocket losses and deterioration of the environment, there's going to be considerable more action. The next time you see a muddy, silt-ladden stream, figure that one way or another it is costing you money, they suggest.

Plus Factors in Erosion Control

Take these examples of research in South Dakota which should help to bring awareness of the plus factors in soil conservation as a pollution preventative or deterrent:

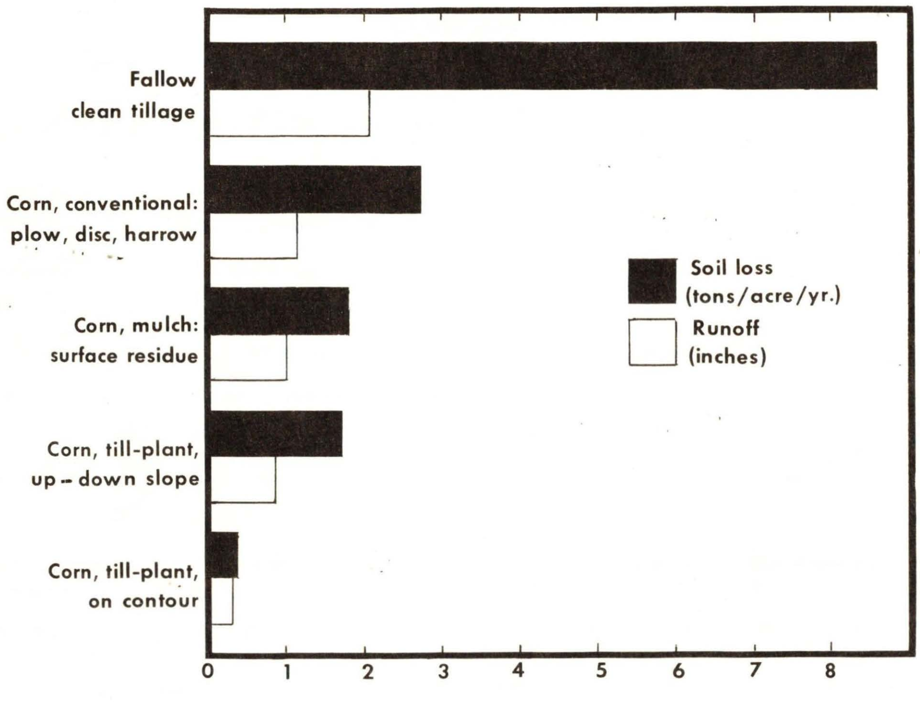
In Lake County on a 5% to 6% slope, soil loss amounted to 8.6 tons an acre annually from fallowed land with clean tillage. More than 2 inches of water runoff was lost. Both soil and water runoff losses were reduced progressively with different cultural practices (see chart). These losses were measured on a slope only 72 feet long. Both soil and water losses increase as the slope becomes longer. For example, soil losses would be expected to be about 2.2 times greater if the slope length were 300 feet instead of 72 feet.

Indications that longer slope lengths lose more top soil are additionally shown in data from studies of watersheds and reservoirs of the James and Big Sioux rivers where, figures reveal, erosion causes an average loss of a sixteenth of an inch of top soil each year. This amounts to about 10 tons an acre annually.

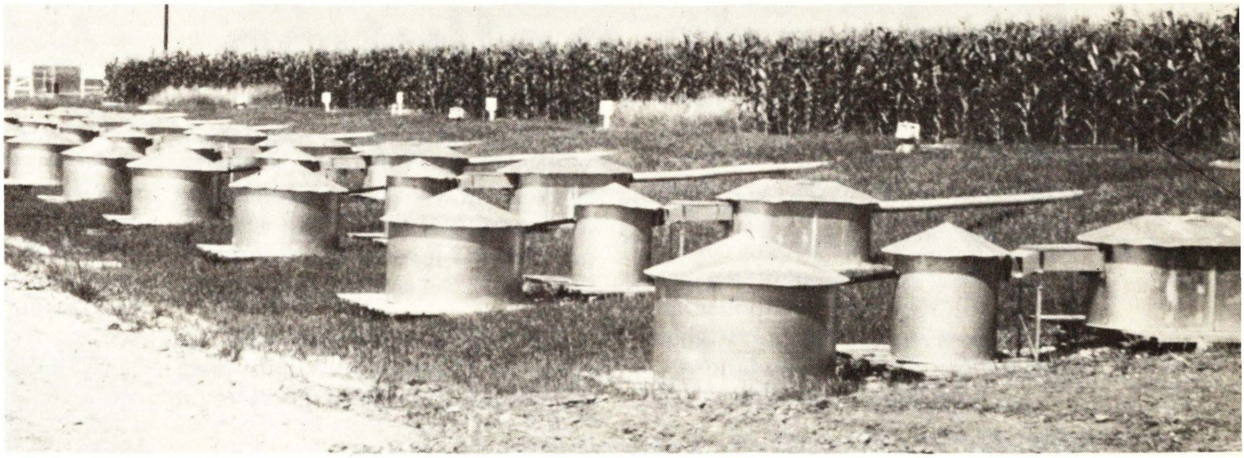
Topsoil losses are viewed as "extremely serious" especially in the last 15 to 20 years where fallow or row crop cultivation has stirred the soil excessively, oxidized out much of the organic matter, and depreciated the granulation and aggregation that gives soil stability against raindrop impact and erosion. Ugly scars of erosion are readily apparent, from delta-like patches of displaced soil to the appearance of

(continued on page 38)

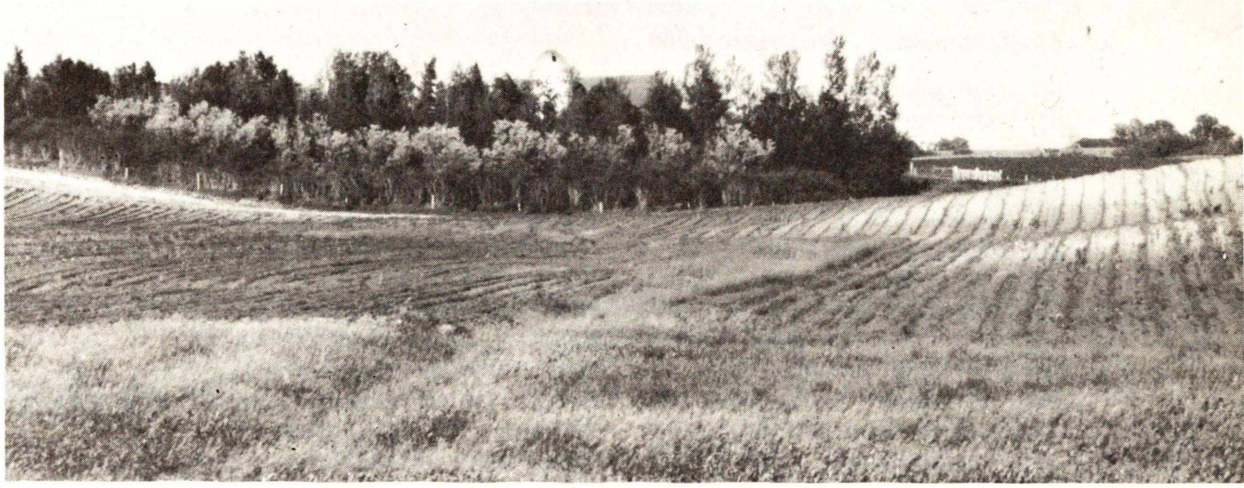
Soil loss and water runoff, Lake County USDA Agricultural Research Station, 1965-69.



Soil erosion plots at USDA Agricultural Research Station near Madison.



Buckskin knoll (right) with subsoil showing through as topsoil is eroded away into lower areas of the field.



Rows up-and-down hill and over terraces. Note eroded topsoil in foreground.

Usual reason: mis-use...

herbicide pollution

By
W. Eugene Arnold, assistant professor,
Plant Science Department, Agricultural
Experiment Station.

When weed control with herbicides pollutes air, water, or soil it is usually because of a single reason: *mis-use*. The remedy is seldom costly and actually may mean a saving through proper application procedures that conform to thoroughly tested recommendations.

Air pollution may result from the physical movement of spray drops or vapor by wind onto desirable but susceptible vegetation. Most of the air pollution occurs because of unwise use of potentially dangerous herbicides such as 2,4-D or Dicamba near susceptible vegetation.

Water pollution occurs also because of misuse of normally safe compounds either near water or on land very susceptible to soil erosion. Most herbicides enter water streams adsorbed onto eroded soil particles. This amount is small in relation to other forms of water pollution because of the relative rapid breakdown of most herbicides.

Soil pollution may occur when a persistent herbicide is used to control weeds in a crop tolerant of the herbicide. The farmer must be careful that he does not follow the next year with a susceptible crop.

Air Pollution Worst

Of the three types of environmental pollution, air pollution may well be the most costly and most dangerous because plants other than the target plants may be injured.

Much has been accomplished to

Erosion costs . . . (from page 36)

thin and pale crops on eroded uplands as compared to lush crops growing on footslopes with deeper soil previously carried from uplands.

Advantages of Deep Soil

Corn research in Spink County on non-irrigated land revealed several advantages of a deep soil (in this case Beotia silt loam) over an adjacent shallow soil (Zell silt loam). Nitrogen content in the Beotia averaged 15% to 20% greater than the Zell, roots penetrated deeper to better use stored moisture resulting in only 0.7 of an inch of available water left in the Beotia at harvest time compared with 2½ inches in the Zell. The yield was 68½ bushels an acre on the Beotia, 33.7 bushels on the Zell.

In Clark County experiments it was found that slightly more than 2 inches of rainfall caused soil loss at a rate of nearly a ton an acre for a crop planted *up-and-down* a slope of slightly less than 5% and about 72 feet long. An adjacent experiment with the crop planted *across* the slope showed a saving of more than half the rainfall runoff and soil loss was less than a fourth of that from planting up-and-down the slope. Additionally, per acre yield comparisons showed a 10-bushel increase for corn and a 38-bushel increase for oats when planted across the slope. The yield increase apparently resulted from conserving the precipitation in the across-slope or contour planting system. The short, intensive storms were found to cause some of the greatest runoff and soil losses.

Narrow Row Soybeans

Research with soybeans indicates that characteristics of new varieties are different and improved production techniques are needed. One technique is use of narrow rows for some varieties. The erosion potential of wide row soybeans (rows 36-42 inches wide) can be serious. More winter protection is available following harvest of drill planted soybeans while row crop soybeans often provide cover only equivalent to modified summer fallow or fall plowing.

What can be done about it all? For several years Agricultural Experiment Station agronomists and soil scientists have advocated six rules to follow, all or any one of which are aimed at reducing soil erosion:

- Minimum tillage of soil.
- Keep crop residues on surface.
- Use contour cropping and cultivation.
- Use sod crops in rotations.
- Use sediment trapping structures (terraces, etc.) where needed.
- Avoid black fallow and bare land surfaces.

Additionally, if you are looking for sources for help to curtail erosion, it's easy to remember a couple of quite descriptive names: Soil Conservation Service and Soil Conservation District.□

Aerial Photos

This man gets high every time he spots marijuana.

About 2,000 feet high in the sky, that is.

He's found a way of spotting growing marijuana (wild hemp) through interpretation of aerial photographs. The method can cover thousands of acres in less than an hour, putting the spotlight on infestations of the weed growing wild along streams, fence rows and other remote places.

Not just any aerial photograph can distinguish growing marijuana from other vegetation, explains the developer of the method, Fred A. Waltz, data specialist with the Remote Sensing Institute headquartered at South Dakota State University. First, black and white infrared film is exposed from an airplane flying at about 2,000 feet. Then the film is processed through a special photo interpretation device.

The first photo flight was made last year and because infrared light reflectance of marijuana differed minimize drift hazards, through application systems and pesticide formulation. Yet, the increasing use of pesticides, the lowered residue tolerances, and an increasing public concern with air and water pollution make even better control of drift imperative.

Some ways to reduce spray drift are by spraying under ideal weather conditions, by decreasing the distance from the nozzle orifice to the target, and by eliminating the fine droplets from the spray during application. Any process that eliminates the fine drops should not increase the size or number of very large drops, since the resulting reduced coverage lowers the effectiveness of many pesticides.

The droplet size is influenced by several conditions including nozzle type and orifice size, spraying pressure, and fan angle. However, modifying the spray mixture itself appears to be the most promising of the few remaining, relatively untapped means of eliminating the fine spray drops. Agricultural Experiment Station research this summer will study several methods of modifying the spray mixture that can be adapted for cropland spraying.

Seek More Stickiness

Many materials are available that increase the apparent viscosity (stickiness) of sprays; hence, they should reduce the drift when properly added to the mixture. Many are too expensive, others require too precise control of conditions, and some remain to be evaluated. Those that have been introduced and seem nearest to acceptance are Dacagin, Norbak, and Vistik. These are all available in dry form to add to water-based sprays, and have been used almost exclusively with herbicides.

One method which will be studied to increase viscosity is use of a water-in-oil or "inverted" emulsion. Such "inverts" have reduced air drift by roadside sprayers but they are limited to use with phenoxy-acid and certain other herbicides where good coverage is not necessary. They also have the disadvantages of being unstable, and of increasing the phytotoxicity of the emulsion. Economically, they compare favorably with other spray thickeners now available.

New research ideas to be tested include spraying a herbicide solution or emulsion in the form of a high density foam and spraying a herbicide which has each chemical molecule linked with another molecule so that a polymer is formed. These polymerized molecules theoretically reduce drift during application and volitilization after application.□

Spot Marijuana

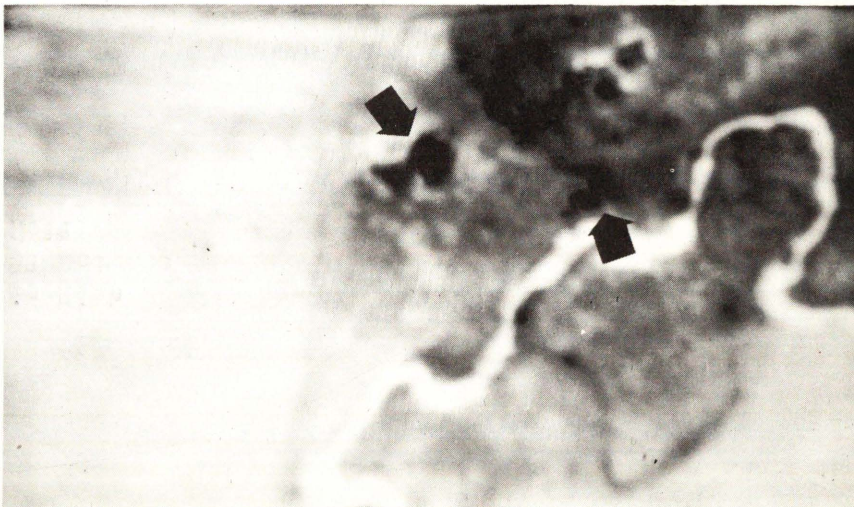
from other plants at the time of this flight, stands of the weeds as small as a yard square could be pinpointed. Timing of the flights is extremely important.

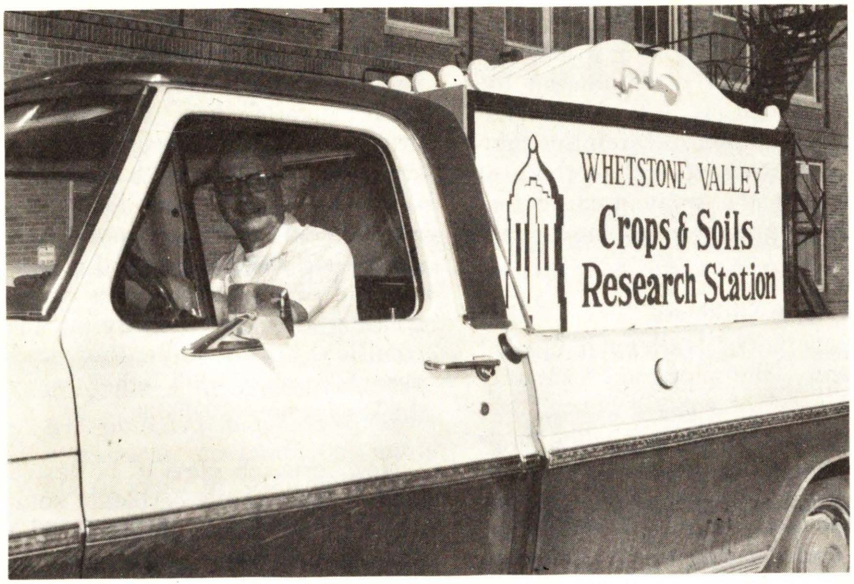
This is the type of information being sought in Remote Sensing Institute and Agricultural Experiment Station research to use faster and wider ranging aerial remote sensing to spot plant diseases, insect infestations, drought stress, even predicting crop yields.

Flights were made over Moody County last July in cooperation with studies by Ben Nelson, State Weed Control Supervisor, and Lloyal Erickson, county weed supervisor, to find quicker, easier ways to locate infestation of wild hemp, according to Dr. Waltz. "Windshield surveys" by the Flandreau Kiwanis Club along with surveys by Nelson and Erickson provided "ground truth" that established occurrence of wild hemp at definite locations. Flight over these areas, followed by interpretation of the photos, established the "fingerprints" of the weed which show up on the special film. Buckbrush appears about the same as wild hemp on color film but the separation process on black and white infrared film provides the difference, says the remote sensing specialist.

Experts say most wild hemp is descended from plantings years ago. During World War II, for example, farmers were encouraged to grow it as a replacement for hemp supplies from the Far East.□

Wild hemp growing in two areas (arrows in photo at right) appears as black spots on this section of an aerial photo made from the screen of a photo interpretation machine at the Remote Sensing Institute at SDSU. The U-shaped black area at top center is also wild hemp. Left photo shows an area of wild hemp growing last year along a stream in Moody County depicted by arrow at right in the aerial photograph.





Brand new green and white identification signs will soon be erected near various Agricultural Experiment Station research installations throughout the state as well as for sites associated with the SDSU campus. Milo A. Potas, visual aids, who has made about three dozen of the signs, prepares to deliver some of those for northeastern areas of the state.

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